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THE NOBODIES,—A SEA-FARING FAMILY.

By the Rev. T. R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.

CHAPTER VI.

IT is a disadvantage for any group to be without a popular name. To call the Pycnogonida "sea-spiders" is embarrassing, because it appears to class them with the Arachnida, from which good authorities consider them distinct. To call them "sea-insects" is still less satisfactory, because it sets wingless creatures flying in the face of facts. Some insects, it is true, are apterous, but none of them have more than six legs, whereas no representatives of this order have fewer than eight. Their superficial resemblance to the Phalangiidæ would suggest the term "sea-harvestmen," but it is cumbrous. The title of "Nobodies," alluding to their ascetic meagreness of frame, is too negative. To name them "sea-daddies," out of respect to the attenuated elongation of their limbs, might be thought undignified and over-familiar. A compromise may be found in the name "sea-spindles," agreeing with their Dano-Norwegian appellation "Söspindler." This has several recommendations. It recalls the services rendered to the tribe's elucidation by a long series of Scandinavian authors. It plainly notes the exclusively marine habitat of the group, and it is justified not only by the spindle-legged character of the species in general, but by the spindle-shaped proboscis in several, and the fusiform ovarial joints in the limbs of the females at maturity. In an interesting paper on the phylogeny of the group, J. E. W. Ihle ("Biol. Centralblatt," Vol. 18, p. 603, 1898) demands the acceptance of Pantopoda as its technical name, but Leach's Podosomata would have a preferential right, if there were the least necessity for relinquishing the time-honoured designation Pycnogonida.

Though the most critical discoveries connected with this subject were not first published in our language, several works of primary importance for an understanding of the whole matter have been given to the world in English. On the other hand, our native writers, as distinguished from those who have written in our native tongue, have not always been pre-eminent for clearness of description. Nevertheless, it is desirable to know what they have done, and where they have worked, both that we may have such credit as properly belongs to us, and that opportunities may be used in the future for clearing up what they have left obscure in regard to species inhabiting the home waters of Great Britain.

Pennant in his "British Zoology" (Vol. IV., p. 43, Pl. 19, Fig. 7; 1777) figures Ström's *Pycnogonum littorale*, showing that the species was then already known on our coasts, although its correct names did not penetrate our insular science till more than half a century later. In 1800 a paper entitled "Descriptions of some Marine Animals found on the Coast of Wales. By the late John Adams, Esq., F.L.S. Read February 6th, 1798" ("Trans. Linn. Soc., London," Vol. V., p. 7), begins with the following contribution to our subject:—

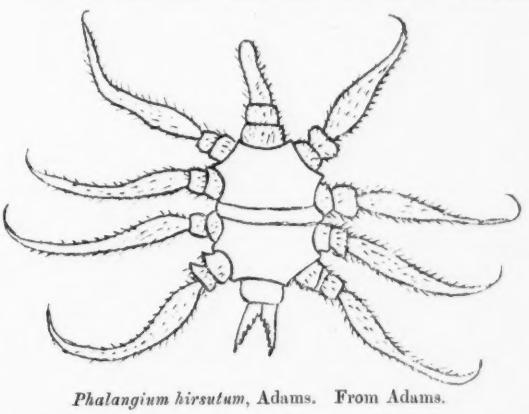
"PHALANGIUM.

"1. *grossipes*. P. corpore minuto cylindrico, humeris tuberculato, pedibus longissimis. *Linn. Syst. Nat. Ed.* 13, *p.* 1027. Milford Haven.

"*Obs.* To the minute and accurate description given in the *Systema Naturæ* I can have nothing to add, except that its colour is a dirty red.

"2. *hirsutum*. P. corpore subplano decemangulo. Tab. II. *Fig.* 1, 2. Milford Haven. Tenbigh.

"*Obs.* Body oval with ten angles, and marked with a transverse band near the centre; antennæ



Phalangium hirsutum, Adams. From Adams.

serrated on the interior side; feet eight, hairy; tail cylindrical, obtuse; colour palish brown; length $\frac{1}{3}$ inch."

It is not without interest to observe what could be regarded as minute and accurate description in natural history at the close of the eighteenth century. The second species evidently poses as new, but it is more like the already patriarchal *Pycnogonum littorale* than anything else, if we may regard the serrated antennæ as due to an

accidental slitting of the abdomen; but neither figure nor description shows for certain which is the head and which the tail of this problematical animal. Its names only once reappear when Leach, in the year 1816, in the fifth edition of the "Encyclopædia Britannica" by a slip of memory attributed them to Montagu in place of the species which that excellent observer really established. *Phalangium spinosum*, Montagu, found in South Devon ("Trans. Linn. Soc.," Vol. IX., 1808), still retains its earliest specific name. It was, however, very early confounded by Leach with the Greenland species *Pycnogonum spinipes*, O. Fabricius, and consequently transferred to Latreille's genus *Phoxichilus*. Hence arose a long-standing confusion, authors apparently supposing that the genus was based on the species from Devonshire, and not knowing that Latreille instituted it in 1804, before Montagu's species had been heard of.* In a later work (1810) it is curious to read the French professor's confession that he had even then only seen a single pycnogonid. This contrasts not only with modern testimony to the commonness of Sea-spindles but with a remark made by Leach as early as 1814, for at that date, when discussing Latreille's genus before the Linnean Society, he says of it, "I possess many indigenous species, but have not yet worked out their characters." Had he ever accomplished this working out, he would probably have found that he had been mistaken as to the generic affinities in at least some of his specimens.

A second species from the coast of Devon was described and figured by Montagu as *Phalangium aculeatum*. This was transferred by Leach to the genus *Nymphon*. It is misquoted by Costa in 1838 as *Phalangium oculatum*. Though it has otherwise dropped out of recent synonymy, it is probably identical with the earlier *Phoxichilidium femoratum* (J. Rathke), 1799. J. Rathke is not to be confused with the later and, at present, better-known H. Rathke. In designating his species as conspicuous for its femora or thighs, he unconsciously records his ignorance of the fact that this dilatation of the fourth or femoral limb-joint is a feminine attribute common to nearly all the tribe. It is safe to infer that he had a female specimen in view, while that which Montagu describes as having ovigerous legs, and which he figures with the thighs undilated, was clearly a male.

The next development of the subject by an English author is due to Leach, who, in 1814 ("Zoological Miscellany," Vol. I., p. 33), founded the genus *Ammothea* for an American species, leaving to subsequent observers the discovery of its English companions. In the same volume Leach described and figured his *Nymphum gracile*, adopting the distorted form of *Nymphon* apparently from Lamarck. The species, he says, "inhabits the British seas everywhere; but as it never attains the size of the *Phalangium*, misnamed by Linné *grossipes* (which is figured by Ström in his history of 'Sondmor,' 208, tab. 2, fig. 16), we are doubtful if it be the same species; but as the Linnean name is so ridiculously inapplicable, little fault can be found with the more appropriate name for which it has been exchanged" ("Encycl. Brit.," Fifth Edition, Art. Annulosa, p. 433). Still a little fault *can* be found. Leach, if he thought the English species identical with Ström's, should have adopted Ström's *marinum* as its name. Probably Linnæus in calling it *grossipes* thought only of the great length of the limbs, not of thickness, which that word more properly implies. But *gracile*, as it has turned out, is itself not a good choice, because it attributes to a single species the tenuity which is characteristic almost throughout the genus *Nymphon*. Nevertheless, *N. gracile* holds its ground, only not in place of *N. marinum* but by the side of it. *N. grossipes* (O. Fabricius) is distinct from both, an Arctic species likely to be rare if found at all in our waters.

In 1821, the American naturalist, Say, described a new genus and species as *Anaphia pallida* ("Journ. Acad. Philadelphia," Vol. 2, p. 59), which has this particular interest, that E. B. Wilson, in 1878, admits the possibility of having to cancel his own *Anoplodactylus lentus* in favour of his fellow-countryman's earlier names. The species itself is described by Verrill and Smith in their treatise on Vineyard Sound (1874), as a singular long-legged pycnogonid, clinging to and creeping over the hydroids and ascidians on shore and in shallow water, and most frequently deep purple in colour, though grey and brown specimens are also often met with. They borrow for it from yet another American author the name *Phoxichilidium maxillare*, Stimpson, 1853, but Stimpson's species is now accepted as itself a synonym of the still earlier *Ph. femoratum* (Rathke). Sabine's description of the great arctic *Colossendeis proboscidea*, in 1821, has been already mentioned. At the same time he discussed two arctic species of Nymphon, which, in a hesitating way, he identified respectively with the *grossipes* of O. Fabricius and the *hirtum* of J. C. Fabricius. Nymphon is probably a masculine form, but Nymphum is certainly a neuter one, so that Sabine's change of *Nymphon hirtum* into *Nymphum hirsutus* can scarcely be commended. None of his three species have been found in British waters, at least according to records that are above suspicion. The next English writer who contributed to enlarge knowledge, not only of the subject in general, but of its relation to our own fauna, was Dr. George Johnston. To him is due the genus *Pallene*, defined in 1837 for the species *P. brevirostris*, from the coast of Berwickshire (Miscellanea Zoologica, in Jardine's "Magazine of Zoology and Botany," Vol. I., p. 380). At the same time he established the genus *Orithyia*, a good genus, but with a pre-occupied name, for which Milne-Edwards, in 1840, substituted *Phoxichilidium*. The representative species had already been carefully described and figured by Johnston, in 1832, as *Nymphum coccineum* ("Zoological Journal," p. 489, 1828 on title page). Elsewhere he says, "It lives amongst sea-weed in Berwick Bay, and when at rest, with the legs drawn up, it so closely resembles some of the fine coloured confervæ, but more especially a detached portion of the Chóndria articulàta, as to be easily overlooked. It appears to me interesting, in so far as its transparency allows us to examine its circulating system with an accuracy which, perhaps, no dissection could enable us to amend" ("Loudon's Magazine of Natural History," Vol. 6, p. 42, 1833). This has proved to be the *Ph. femoratum*, already noted as occurring in the United States of America, and in South Devon. If Montagu gives his species "colour dusky black," while Johnston describes the body and legs "of an uniform fine transparent red colour," Sars corroborates both by saying that "the colour is generally a more or less vivid red, in particular of specimens from shallow water, and sometimes dark brownish, or a sepia tint."

The year 1837, in which the American writer Eights described his bright scarlet *Decolopoda australis** ("Boston Journ. Nat. Hist.," Vol. 1, p. 204), from the south, and Johnston inaugurated his new genera from the north, began a period of great activity in this subject. In 1838, the Italian O. G. Costa among his Neapolitan "Aracnidi," published the pycnogonid genus, *Phanodemus*, with three species which still await precise identification. To the

* *See* KNOWLEDGE, Vol. XXV, p. 187. On the same page, 14 lines from the foot, the genus *Pallene* was by inadvertence attributed to Goodsir instead of Johnston.

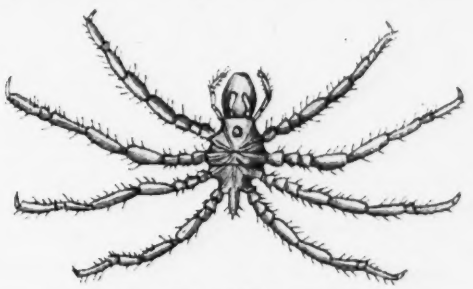
* It is most probably this species for which Rafinesque suggested the generic name *Decatelopus*, as he informs us in his Autobiography, p. 106, 1836,

same fauna A. Philippi, in 1843, contributed three more species in his genera *Endeis* and *Pariboea*. Unfortunately these also remain obscure. A year earlier Henry Goodsir described as *Pephredo hirsuta* a species from the German Ocean. The generic name is preoccupied. The genus is perhaps the same as Costa's uncertain *Phanodemus*. In the description of the figure the species is called by an

Phanodemus collaris, Costa. Clearly the dorsal, not, as Costa supposed, the ventral aspect.

alternative name *capillata*. On the obscurity of Goodsir's *Pasithoe vesiculosa* from the Firth of Forth comment has been already made. Hoek, in 1881, considers it "absolutely impossible to recognise," nor is it recorded either in the "Museum Normanianum" of 1886, or in Dr. Calman's still longer catalogue of specimens at University College, Dundee, 1901. Goodsir's *Phoxichilidium globosum* from Orkney, is supposed by Sars to be probably identical with the often mentioned *Ph. femoratum*. His *Nymphon giganteum*, taken in the sea at Embleton, off the coast of Northumberland, is identified with Ström's *N. marinum*. His *N. johnstonii*, from the German Ocean, his *N. pellucidum* and *N. minutum* from the Firth of Forth ("Edinburgh New Philos. Journ.," Vols. 32, 33), and his later *N. similis* ("Ann. Nat. Hist.," 1844), are foundlings which still utter feeble but unanswered cries for recognition. On the other hand, his *N. spinosum* is accepted by Sars as an undoubted member of Sars's own genus *Chætonymphon* (1888), and his *Pallene circularis* as belonging to Wilson's *Pseudopallene*, which as already shown, is a synonym of Latreille's Phoxichilus. At the same period attention was being paid to this subject by Milne-Edwards and Quatrefages in France, and by Erichson in Germany, but with more searching fulness by Kröyer in Denmark. The careful descriptions published by him in the Danish "Naturhistorisk Tidsskrift," were finely illustrated in the folio Zoological Atlas to "Gaimard's Voyage en Scandinavie." On the advances made by Kröyer, and the mistakes which even he could not wholly avoid, it is unnecessary here to expatiate, since subsequent authors have absorbed all that was meritorious in his work into more generally accessible languages. Our own Adam White described some foreign species in 1847, and two years later the great American naturalist, J. D. Dana, established a genus *Astridium* for an obscure little eastern specimen which he afterwards called *Pycnogonum orientale*. The arctic *Chætonymphon hirtipes* (Bell) was described in Belcher's "Last of the Arctic Voyages, 1855." In his useful little manual of "British Marine Zoology," of that same year, the late Philip Henry Gosse devotes a couple of pages and several figures to the Pycnogonida. It cannot, however, be said that this part of his work does much honour to the science of Great Britain. He is apparently quite ignorant of Goodsir's labours, but on his own account he supplies us with two new species, *Phoxichilidium olivaceum*, unrecognisably figured, and *Nymphon pictum*. Not a word of specific description is given. We are not told whence the species were obtained. We are even left to guess that they are intended for new ones.

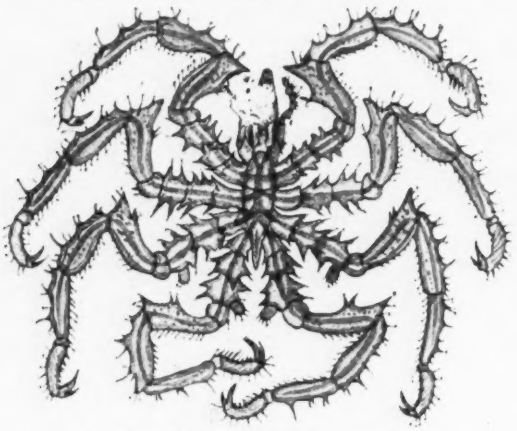
The parasitism of Phoxichilidian larvæ in hydroid zoophytes was, it is said, first discovered by Gegenbaur in 1854. It was then, as it seems, independently observed by Dr. Allman in 1859, and again, a couple of years later by Mr. George Hodge. The subject has been discussed by Semper, Dohrn, and others, and in 1882 Dr. v. Lendenfeld named a new Australian species *Phoxichilidium plumulariæ* in allusion to this very habit. Hodge published his researches in the "Transactions of the Tyneside Naturalists' Field Club," Vol. 5, 1863. In the same volume he reported ten species taken between the Dogger Bank and the coast of Northumberland. Two he claimed as new to science, and two, *Nymphon hirtum*, Fabricius, and *N. brevitarse*, Kröyer, as new to the British fauna. But he subsequently recognised that his *Pallene attenuata* was a synonym of the species which should apparently now be called *Anaphia petiolata* (Kröyer). The Fabrician species, as *Chætonymphon hirtum*, is recorded in Calman's list as occurring in the Firth of Forth, so that Hodge's determination may well be accepted. But in regard to *N. brevitarse*, Sars declares that it has not been observed "either on the coasts of Norway or England, as all statements of its occurrence there have unquestionably arisen from confounding the animal with either *N. gracile*, or quite young examples of some or other of the known species" ("Norwegian North-Atlantic Exp.," p. 63, 1891). Hodge's *N. brevirostre* has since been recorded from South Devon. In the "Annals and Magazine for 1864" (Ser. 2, Vol. 13, p. 113) the same author gives a list of all the species up



Pariboea spinipalpis, Philippi. From Philippi.

to that date noted as inhabiting the British seas. Of the thirty-two, seven are described as new to science, and three are reported as new to our fauna. Of the new species, two are placed in *Ammothoa*, by which Leach's *Ammothea* is intended, and three in a new genus, *Achelia*, which is usually deemed to be not really distinct from Leach's genus, but to represent its adult forms. Hodge's *Ammothoa brevipes*, a twenty-fifth of an inch in length, from the Durham coast, is thought to be probably the young of his *Achelia echinata*, now transferred to *Ammothea*. His *A. longipes* from Polperro is doubtfully

identified by Hoek with *Ammothea pycnogonoides*, Quatrefages, 1845. His *Achelia lævis* from Polperro is transferred to *Ammothea* by Sars. His *Achelia hispida*, from the same locality, remains unrecognized. His *Phoxichilidium*



Ammothea echinata (Hodge) ⅓. From Sars.

virescens, also found in Cornwall, is assigned to *Anoplodactylus* (the synonym of *Anaphia*) by Sars, who further makes Hodge's *Pallene pygmæa*, from the Durham coast and Plymouth, a synonym of Kröyer's *Anaphia petiolata*. Of the three species of *Nymphon*, Kröyer's *mixtum* and *longitarse* were taken by Hodge himself on the Durham coast, and Ström's *marinum* by Norman, who in his Shetland dredging report (Brit. Assoc. Rep. for 1868) refers to the capture as "a single specimen, the only known British example, dredged in 1861 in 80 fathoms, 40 miles east of Whalsey Skerries." In 1867 Hodge added a new species, *N. rubrum*, to our fauna from the coast of Durham.

In regard to the still vague genera and species which O. G. Costa introduced in his quaint and quaintly named Italian treatise, "Microdoride mediterranea," we must be content to name his *Platychelus sardonicus*, his *Alcinous vulgaris*, his *Alcinous megacepholus*, and to borrow sympathetically his quotation from Pliny, "In his tam parvis, atque tam nullis quæ ratio, quanta vis, quam inextricabilis sapientia!" which is as good as saying that in these little Sea-spindles, these insignificant Nobodies, there is such plan and power displayed as speak of a Wisdom past our finding out.

Little work has been done of late in Great Britain and Ireland on the Pycnogonida except by E. J. Miers ("Ann. Nat. Hist.," 1875; "Phil. Trans.," 1879; "Zool. of H.M.S. 'Alert,'" p. 323, 1884), and G. H. Carpenter, the latter of whom in 1892 ("Proc. R. Dublin Soc.," Vol. 7) founded the genus *Parapallene* to receive Hoek's *Pallene australiensis* and a new species, *P. haddonii*. On the other hand, in English have appeared several works of first-rate importance. Thus the "Challenger" report, by Dr. P. P. C. Hoek, in 1881, is a monograph teeming with instruction in our dialect, not in the author's native Dutch. The treatises by E. B. Wilson (1878, 1881), and T. H. Morgan (1891) do credit to our language on the other side of the Atlantic. Dr. Meinert, of Copenhagen, in his excellently illustrated memoir ("Ingolf Exp.," 1899) addresses us in our own tongue, not in Danish. G. O. Sars, in 1891, sends forth from Christiania his pre-eminently valuable discussion of the group in parallel columns of English and Dano-Norwegian, supplementing both, after his manner, by that fine language of the pencil with which printed words cannot easily compete. In the works mentioned will be found long lists of literature, too long for reproduction here, or for critical analysis. Only exhausted limits of space indeed can excuse the omission of Lilljeborg, Hansen, Haswell, Ives, Ortmann, Adlerz, Caullery, Pocock, and others* from the present survey. Much has been said of mistakes and obscurities, yet scarcely a page can be studied without finding in it something useful and suggestive. If we pride ourselves on having valued works written by foreigners in our own vernacular, we have not a monopoly of such distinction. The Italian Philippi writes in German. The Russian Schimkewitsch writes in French and publishes at Rome ("Atti dei Lincei," Ser. 4, Vol. VI., 1890). Hoek's "Nouvelles Études sur les Pycnogonides," 1884, as the title implies, is written in French. This very valuable essay includes several pregnant observations on Dr. Dohrn's fine German monograph of the Mediterranean Pycnogonids. In the same way the Norwegian monograph by Sars not less usefully discusses the systematics of Hoek's "Challenger" report, and the whole series of works, throwing light each upon each, are gradually opening the way for well-ordered classification and luminous understanding. In his little "epoch-making" essays of 1876, 1877, the Italian Cavanna modestly explains that when he had made his discovery about the sexes in this tribe he could scarcely credit himself till he found that Dujardin, in 1849, and Semper, in 1874, had practically made the discovery, without having the courage to believe it. So it is in this small field, as Dryden says of a larger one, that "great contemporaries whet and cultivate each other, and mutual borrowing and commerce make the common riches of learning, as it does of civil government."

In the retrospect now concluded, an endeavour has been made to take note of all the genera, good, bad and indifferent, that have hitherto been set up. To have distinguished all the species would have taken far too long, and to have named them all without distinction would have been more tedious than useful. Some details of organization have been left unnoticed as too technical for the general reader. For naturalists who make the ocean their playground it should be satisfactory to know that the Sea-spindles are obtainable from its tide-marks downwards to three miles below the surface. In our islands they are not scarce. We can with some assurance boast of ten genera, and twice that number of species. In the milder Mediterranean climate their abundance is strongly attested. They flourish in the arctic regions. We have reason to be sanguine that they will yield good results to antarctic exploration. They are known from tropical waters. From all the coasts of Europe, from the seas of Asia and Australasia, of South Africa, and of America, both North and South, species have been obtained, so that the oceanic distribution of the tribe may be described as cosmopolitan. In natural history its past has surely not been uninteresting, and, one may venture to think, it has a future.

MODERN COSMOGONIES.

By AGNES M. CLERKE.

III.—THE NEBULAR HYPOTHESIS VARIED AND IMPROVED.

"RESTORATIONS" often go very far. Things may be improved beyond recognition, nay, out of existence. So it has happened to the Nebular Hypothesis. *Stat nominis umbra.* The name survives, but with connotations indefinitely diversified. The original theme is barely recalled

* Prof. A. E. Verrill institutes the sub-genus *Ammothella*, in "Trans. Connecticut Acad.," Vol. 10, 1900.

by many of the variations played upon it. Entire license of treatment prevails. The strict and simple lines of evolution laid down by Laplace are obliterated or submerged. Some of the schemes proposed by modern cosmogonists are substantially reversions to Kant's "Natural History of the Heavens"; the long-discarded and despised Cartesian vortices reappear, with the *éclat* of virtual novelty, in others; nor are there wanting theories or speculations reminiscent even of Buffon's cometary impacts. Moreover, the misleading fashion has come into vogue of bracketing Kant with Laplace as co-inventor of the majestic and orderly plan of growth commonly designated the "Nebular Hypothesis." This has been, and is, the source of much hurtful confusion. Save the one fundamental idea—and that by no means their exclusive property—of ascribing unity of origin to the planetary system, Kant's and Laplace's evolutionary methods had little in common. Their postulates were very far from being identical; they employed radically different kinds of "world-stuff"; and the "world-stuff" was subjected, in each case, to totally dissimilar processes. Yet it is often tacitly assumed that to defend or refurbish one scheme is to rehabilitate the other. Under cover of the intellectual vagueness thus fostered, a backward drift of thought is indeed discernible towards the standpoint of the Königsberg philosopher. It is recommended, not so much by the favourable verdict of recent science as by the wide freedom of the prospect which it affords. The imperative guidance of Laplace, reassuring at first, led to subsequent revolts. But Kant is highly accommodating; one can deviate widely from, without finally quitting the track of his conceptions; they are capacious and indefinite enough to comport with much novelty both of imagination and experience, and hence lend themselves with facility to the changing requirements of progress.

A noteworthy attempt was made, in 1873, by the late Édouard Roche, of Montpellier, to reconstruct, without subverting, Laplace's Hypothesis. This remarkable man lived and died a provincial; only a few scattered students have made acquaintance, at first hand, with his works; his fame, always dim, now already begins to seem remote. Yet a score of years ago he was still lecturing at the Lycée of his native town. The waters of oblivion have grown, perhaps, more turbid than of yore. Anyhow, Roche of Montpellier is only vaguely remembered, and that by a specially educated section of the public, as having fixed a limit within which a satellite cannot revolve intact.* Nearer to the ruling planet than 2·44 of its mean radii, it could not—apart from improbable conditions of density—maintain a substantive globular status under the disruptive strain of tidal forces. In point of fact, all the moons so far discovered in the solar system circulate outside "Roche's Limit"; and Saturn's rings, which lie within it, owe to that circumstance, it may plausibly be asserted, their pulverulent condition. Professor Darwin, accordingly, considers knowledge of that condition to date from 1848, the year in which Roche published the law involving it as a corollary.†

Roche was the precursor of Poincaré and Darwin in those momentous investigations of the figures of equilibrium of rotating fluid bodies which have opened up new paths and disclosed untried possibilities in evolutionary astronomy. His researches, moreover, into the origin of the solar system ‡ constituted a reinforcement of primary account to the strength of Laplace's position. He was perhaps its most effective defender, repairing breaches, and throwing up skilfully constructed outworks. Adopting the same premisses, he drew virtually the same conclusions as Laplace, ingeniously modifying them, however, so as to evade certain objections, and temporarily to silence the less obstinate cavillers. His results were, indeed, almost as difficult to disprove as they had been to obtain. They were arrived at laboriously, legitimately, by long-drawn analytical operations; and the reasonings survive in full credit, even although the initial conditions they started from now wear an aspect of unreality. Thus, the invention of *trainées elliptiques* not only usefully met an argumentative emergency, but still remains as a supplementary adjunct to cosmic processes. Undeniably, polar annulation may have played a part in planetary formation; the possibility cannot be gainsaid. The "elliptic trains" investigated at Montpellier were huge nebulous strata detached from the polar regions of the primitive spheroid, which, bringing with them the low rotational velocity proper to that situation, tended, some to constitute interior equatorial rings, others to become agglomerated with the central mass. But their incorporation should have had as its consequence—since the "law of areas" is inviolable—a quickening of angular rotation throughout the nebula. The "law of areas," it may be explained, is merely a short title for the "law of conservation of moment of momentum," which prescribes—as we know—that the sum-total of the areas described in a given time on a given plane by the members, or constituent particles of a rotating system, multiplied by their several masses, remains constant under all conceivable circumstances of re-arrangement or mutual disturbance. Hence, approach towards the centre, because it narrows the circle, must quicken the speed of rotation. A short line having to sweep over the same space as one of greater length, its moving end must proportionately hurry its pace. An engulfment, accordingly, by the embryo sun of one of Roche's "elliptic trains" would have occasioned an immediate shortening of the period of revolution of both nucleus and atmosphere, an accession of centrifugal force producing sudden instability, and, as a consequence, the separation of an equatorial ring. By this subtly-devised expedient, Roche sought to explain away the difficulty connected with the wide intervals between the planets. For they originated, he conceived, not in the regular course of condensation, but through complications arising abruptly, and exceptionally. The "limiting surface"—as he called it—of the nebula might also be described as the atmospheric limit. It corresponds to the widest possible extension of a true atmosphere. Its boundaries are at the distance just outside of which a satellite could freely circulate in the axial period of its primary. Now the limiting surface, if contraction had proceeded equably, should have retreated continuously, its withdrawal being attended by the shedding of slender rivulets of superfluous matter. But by the introduction of "elliptic trains," stability, artificially maintained (so to speak) throughout long spells of time, was overthrown only by catastrophic downrushes from the shoulders of the nebulous spheroid, when, with the prompt abridgment of the axial period, the limiting surface as promptly shrank inwards, and there was left, outstanding and self-subsistent, the tenuous ring destined to coalesce into a planet. A singular and unexplained felicity of Roche's analysis consisted in the symmetry of time-relations established by it. The successive births of his planets appeared to follow each other at equal intervals. Bode's law of distances (extended by him to satellite-systems) was thus translated in terms of the Nebular Hypothesis.*

* "Mémoires de l'Acad. Montpellier," t. I.

† "The Tides," p. 327.

‡ "Mémoires de l'Acad. Montpellier," t. VIII.

* Wolf, *Bull. Astr.*, t. I., p. 596.

XUM

Kirkwood, in 1864,* had recourse to solar tidal friction for the purpose of changing planetary axial movement from an anomalous into the conventional direction. And he was followed, doubtless independently, by Roche, and by Roche's interpreter, M. C. Wolf, of Paris. Objections to any particular mode of planetary formation, on the ground that its outcome must have been retrograde rotation, lost their validity, they remarked, through the consideration that solar tidal friction would have availed to redress the incongruity. For its retarding action would have ceased only when synchronism with the revolutionary period was attained; that is, when the planet wheeled in its orbit, as Mercury seems to do, turning always the same face inward; and then already direct rotation would have set in, and, becoming accelerated by contraction, should permanently retain the direction impressed upon it by the friction of sun-raised tides. A certain air of plausibility is given to this view by the fact that the only two retrograde planetary systems are situated entirely beyond the possible range of any such manner of influence, and may accordingly be supposed to have preserved unaltered their primitive fashion of gyration.

The late M. Faye was less loyal to tradition than the *savant* of Montpellier. The appearance, in 1884, of his work "Sur l'Origine du Monde" gave the signal for renewed activity, and a larger license in cosmological speculation. Conservative opinions on the subject are now rarely held; the old groove has been, by most, definitively quitted; enquiry becomes continually more individual, and less constrained by prescription. Faye's reform, however, was not avowedly of a revolutionary character. He did not make a clean sweep of the work of his great predecessor, by way of preliminary to setting forth his own more perfect plan. Yet his emendations of it went very deep. Laplace's nebula was of a gaseous consistence, and it stood in a genuine atmospheric relation to the central condensation. That is to say, its strata gravitated one upon the other; they were subject to hydrostatic pressure. Faye ruled things otherwise. The nebulous matrix which he postulated was a vast congeries of independently moving particles, forming a system governed by a single period, in which both gravity and velocity increased in the direct ratio of the distance from the centre. Now globes formed by the method of annulation (admitting its practicability) out of materials thus conditioned should have possessed, *ab initio*, a direct rotation; their axial spinning would have been in the same sense as their orbital circulation. And this it was which recommended to Faye the adoption of a meteoric structure for the inchoate solar system. But the simple law of force regulating it at first would, by degrees, have become essentially modified. That of inverse squares, familiarised to ourselves by long habits of thought, would have begun to supersede it so soon as a sun, properly so-called, could be said to exist. The retrograde planets Uranus and Neptune must, however, by Faye's supposition, have taken shape under the modern regimen; they were then formed subsequently to the earth and all the rest of her sister orbs. This unexpected inversion of the recognised order of planetary age involved the further consequence that the ante-natal offspring of the sun—thus paradoxically to designate them—must have drawn closer to him as his attractive power developed, Uranus and Neptune alone among the entire cortège preserving the original span of their orbits.

Faye's scheme, if it did not meet all the arduous requirements of the problem it confronted, served at any rate to illustrate very forcibly the devious variety of tracks by which nebular evolution might advance towards its goal. The particular one chosen was certainly not clear of impediments. In his pre-occupation with the removal from Laplace's Hypothesis of the flaw relating to planetary rotation, M. Faye had discarded its cardinal merit of explaining secessions of material by the growth of centrifugal force; for no sufficient reason could be alleged why the remodelled nebula should have separated into rings.* The process implies definite and special conditions; it testifies to a symmetrically acting cause. Laplace brought such a cause into play. Faye abolished it, and his annuli, accordingly, wear a fictitious aspect. It is indeed true that an annular structure is commonly visible in nebulæ; but it is begging a most arduous question to assume that nebular spires have anything in common with planet-forming rings.

These would probably never have been heard of save for the Saturnian example. A pattern is easily copied; an idea palpably feasible is tempting to adopt; a demonstration on the *solvitur ambulando* principle cannot but prove convincing. But how, if the rings cannot be made to coalesce into globes? And the difficulty of the transformation becomes more apparent the more clearly its details are sought to be realised. Reversed in direction, it might better find a place in the order of nature. "Analysis seems to indicate," Kirkwood wrote in 1884,† "that planets and comets have not been formed from rings, but rings from planets and comets."

Faye's theory was disfigured by a still more glaring incongruity. Nothing in the planetary economy seems more evident than that the zone of asteroids marks a division between two strongly dissimilar states of the solar nebula. It is a visible halting-place. One series of events came to an end, and there was an interlude before the next began. During that interlude, during the partial suspension of activity which ensued upon the production of the Ajax among the planets, the crowd of planetoids were launched to fill the blank space. Here, if anywhere, nature changed her hand, and tried a fresh method. Faye's shifting of the scene of change to trans-Saturnian regions is then, as M. Wolf justly perceived, non-natural, and undermines the credit of a plan to which the device is essential.

On the other hand, it had the merit of being elastic enough to include the great cometary family. Kant had also, although in an unsatisfactory manner, made room for them; but Laplace had no choice save to regard them as casual intruders from space, the admission of which as natives of his well-ordered domain would have led to the subversion of all its harmonious regulations. Modern enquiries, however, prove comets decisively to be no such stray visitors as Laplace supposed, but to be of the same lineage—however remotely traceable—with the planets, and to own the same allegiance. Drifting with the sun, they form part of its escort on its long, irrevocable voyage, and cannot, save by accidents of perturbation, be driven finally to part from its company. The problems of planetary and cometary origin are then inseparable; the two classes of body are fellow-citizens of one kingdom. Comets become only by compulsion cosmopolitan wanderers from star to star.

There was yet another motive, and semblance of justification, for Faye's reform of the Nebular Hypothesis. The discovery of the conservation of energy supplemented, as we have seen, very happily the mechanics of a condensing nebula by satisfactorily solving the enigma of solar radiation. Helmholtz was thus able, in 1871, to sketch

* *American Jour. of Science*, Vol. XXXVIII., p. 3.

* G. H. Darwin, *Nature*, Vol. XXXI., p. 506.

† *Proc. Amer. Phil. Society*, Vol. XXII., p. 109.

cosmic development as, in its essence, a thermodynamic process on the grandest scale. Yet the alliance entered into, fruitful and fortifying though it was, had an attendant embarrassment. Time had now to be reckoned with. In the cosmogonies of Kant, Herschel and Laplace the allowance of aeons was unstinted. Because the rate of change was indeterminate, they might be permitted to elapse *ad libitum*. But it was otherwise when the driving-power came to be defined. "Conservation of force" implies the measurableness of force. Equivalence cannot be ascertained where no limits are determinable. Knowledge, accordingly, regarding the source of the sun's heat brought with it the certainty that the source was by no means inexhaustible. The stock of energy rendered available by shrinkage from a primitively diffuse, to its present compact state, was enormous, but not boundless. The task then became incumbent upon cosmogonists of proving its sufficiency, or of eking out its shortcomings. The problem is both retrospective and prospective. We look back towards the birth of the sun, we look forward to its demise; and each event has, if possible, to be located on our time-scale. Helmholtz assigned terms of twenty-two millions of years in the past, and seventeen millions in the future, for the shining of our luminary with its actual intensity. Geologists and biologists, however, claimed a much more extended leisure for the succession of phenomena on this globe; and efforts on the part of physicists to meet their demands barely availed to tone down without removing the discrepancy. M. Faye then came to the rescue. His suggestion that the earth took separate form while the sun was still nebulous, was designed to conciliate the demands of those who needed all but eternity for the slow accumulation into specific differences of infinitesimal variations. In this way, a start was gained upon the sun; the preparations for vitality on our planet were going forward long before the lavish radiative expenditure designed to nurture its development had begun. The earth, in fact, was shaping itself for its destiny in advance of the epoch when time began to count for the sun.

This supposed relation of precedence cannot, indeed, be insisted upon; it was imagined to save a difficult situation, and intimates a design more or less academic. The expedient, however, was significant as regards the effect of the introduction into modern thought of the principle of the conservation of energy. It gave definiteness and a kind of solidity to speculation by widening the basis upon which it was made to rest. At the same time it necessitated adjustments between the exigencies of the various sciences, and brought into prominent view apparent incompatibilities only to be removed by prolonged investigations of wide scope and intricate bearings. Modern cosmogony, in short, while disposing of enlarged means has to meet multiplied exigencies.

Sir Robert Ball, nevertheless, regards the origin of the solar system chiefly under its mechanical aspect. Like Helmholtz and Faye, he chooses pulverulent materials to work with; his nebula is a "white nebula." Looking still further back, however, he discerns as its parent an irregular "green" nebula, the jostling movements in which becoming regularised by the elimination of colliding particles, it became flattened down into the "plane of maximum areas"—the fundamental plane conformed to more and more closely as the energy of a system inevitably wastes. He dispenses with the troublesome process of annulation, and starts his planets virtually by Kant's method of accidental nuclear condensation.* A spiral structure, moreover, would be imparted to the entire nebula by the gradual propagation outward of the central acceleration due to contraction.

But would it have contracted? It had, by supposition, reached the stage of approximate unanimity in movement. The great bulk of its constituent bodies circulated in the same direction, in nearly the same plane, and presumably in orbits not deviating much from circularity. Their aggregate condition might then be regarded as permanent and stable. The central mass would, accordingly, no longer be fed by the engulfment of particles brought to rest by their mutual impacts; motion being unimpeded, heat could not be evolved; and the imagined transformation of a disc-like meteoric formation into a sun and planets would fail to come to pass.

What then, we may ask ourselves, is the upshot of these various efforts at reconstruction? They establish, certainly, the unassailable unity of the solar world; and the solar world must be understood to embrace comets and cometary meteors. The arguments favouring this unity have gained enormously in cogency through modern discoveries. For those depending upon structural coincidences and harmonies of movement have been reinforced by others of a totally different nature, furnished by the doctrine of the conservation of energy and the teachings of spectrum analysis. The sun is hot because it was anciently expanded; the energy of position formerly belonging to its particles incontestably provided its present thermal energy; and this amounts to saying that a sphere indefinitely great was once filled by our inchoate system. The conclusion that it arose from an undivided whole through the gradual differentiation of its parts is further ratified by the identity of solar and terrestrial chemistry. Thus, the earth once made an integral part of the substance of the sun; and what is true of the earth is no less true of its sister planets.

Regarding the *modus operandi*, however, of cosmic change, there is no consensus of opinion. Faye alone has striven to elaborate a process enduring the modern tests of feasibility, and his theory has been well-nigh torn to pieces by adverse criticism. That there was, in the beginning, a solar nebula, all are agreed; but whether it was gaseous or pulverulent, whether it shone with interrupted or continuous light, how it became ordered and organised, how it collected into spheres, leaving wide interspaces clear, the wisest are perplexed to decide.

Mr. Moulton concludes from his careful examination of the subject, that "the solar nebula was heterogeneous to a degree not heretofore considered as being probable, and that it may have been in a state" resembling that exhibited in recent photographs of spiral nebulæ.* But, even if all the facts do not chime in with this tempting analogy, there can be little reason to dissent from his intimated opinion that "the Laplacian hypothesis is only partially true, and that we do not yet know the precise mode of the development of the solar system."

* "The Earth's Beginnings," p. 247.

* *Astroph. Journal*, Vol. XI, p. 130.

WHAT IS THE MILKY WAY?

By C. EASTON, D.SC.

THE Milky Way, a "bow in the heavens" in monochrome, and permanent, is unfolded on the celestial vault as the most strange and most amazing of optical errors. Supposing that our retina—an admirable instrument, the most sensitive organ with which God has gifted our body, but yet far from being perfect—supposing that it were improved to such a degree that the extremities of its nervous ramifications presented surfaces that were ten or a hundred times

on a smaller scale to the rays of light; then the images of many small and very close stars would each find their own path of communication with the brain, there would no longer be a "confusion in the despatch." It is true that the accumulation of luminous impressions which takes place now would not be produced, but, instead, all the small stars, down to a certain magnitude too feeble for our perception—say, to the 9th or 10th magnitude—would be seen individualiy in the sky. In such a case we should see on very clear nights a great crowding of stars along a somewhat irregular curve—300,000 stars in the visible hemisphere; it would be like the great atlas of Argelander, the celebrated "Bonn Durchmusterung," spread out on the celestial vault. But we should see nothing of the "Milky Way"—except on a somewhat misty sky which might produce here and there some whitish spots and bands.

This word "Milky Way," the name given to the phenomenon which causes this grandiose optical error, gives rise to some rather curious confusions. It establishes a fundamental distinction between the clusters of stars whose constituents are sufficiently bright and sufficiently separated to be seen as stars (the Pleiades, for example) and gatherings of stars which produce on our eye the sensation of "lacteal" light—although the two phenomena are identical in their nature; whilst the imperfection of our visual organ makes us class together from their appearances, but quite wrongly, gaseous nebulæ and the Milky Way.

The visual organ is not equally good in all men, and this has two results:—1st. What is "Milky Way" for one man is not so for another. 2nd. What is called "Milky Way" in one quarter of the heavens is not so called in another quarter.

Those who are not accustomed to raise their eyes in the evening higher than the gas lamps in the street scarcely know the Milky Way at all, never having bestowed upon it more than a fleeting glance. They are amazed that anyone succeeds in seeing in it more than a band, vaguely and uniformly luminous, and seen with difficulty.

The German astronomer Heis, whose piercing sight has become famous, counted 13 stars in the Pleiades, where even very good eyes see no more than "the hen with her five chickens":—

"Quæ septem dici, sex tamen esse solent."

Heis drew the Milky Way on his charts much larger than other observers. Without doubt he saw its light far outside ordinary limits. Searle has recently published his observations of several "Scattered branches of the Milky Way." Studying these attentively in exceptional atmospheric conditions, he succeeded in some parts in following these vague ramifications to regions near the galactic pole. The astronomer who has perhaps best examined the details of the Milky Way, Dr. Boeddicker, of Lord Rosse's Observatory, says that the background of the sky is nowhere uniformly illuminated, and Mr. Backhouse, of Sunderland, has also written recently:—"I do not think there is a uniformity of light in any part of the sky at a reasonable altitude; it is a question whether one may not say there are streaks and patches of Milky Way all over the sky."

All who are familiar with the appearance of the sky subscribe to this. Thus it would be possible to assert that there is no limit to the Milky Way. It would be more exact to say that, the word "Milky Way" hardly being a definable term, it does not seem possible to establish a distinction between vaguely luminous regions which are undoubtedly connected with the Milky Way, and those (the nebulous region of Coma Berenices, for example) where the relation with the galactic zone is at least very doubtful.

If those who enjoy excellent sight see in general more "galactic light" than others—as is natural—there are also cases where the want of good eyesight produces the effect of galactic light where ordinary eyes do not perceive it. A myopic person will see the Pleiades as a whitish spot, as a galactic spot.* And this brings us back to what I have just said, that "what is Milky Way for one person is not so for another." This is a consideration which must not be omitted when studying the *details* of the Milky Way on drawings made by different observers, for it will exercise a certain influence everywhere where there are groups or lines of stars on the verge of visibility to the naked eye. To give yet another example, which anyone can verify, the star 14 Aurigæ, and the neighbouring small stars (between ι Aurigæ and β Tauri) are seen separately in a very clear sky, but form a luminous line under ordinary atmospheric conditions (or for short-sighted persons). Such luminous lines or groups could thus produce the outlines of factitious luminous spots on the drawing; and similarly for exceptionally good eyesight, still feebler stars, grouped in other fashion, are at the limit of vision, and so we have thus one cause of error.

Another source of error and of divergence is to be found in the circumstance that to compare the light of vague galactic spots it is often necessary to pass the eye rapidly from one spot to another, and thus the luminous impressions accumulate, and are confused on the retina, and we think we see details which do not really exist.

I have wished simply to indicate several reasons why we can never expect *complete* accord between the drawings of the Milky Way made with the naked eye. There are others and even more important ones. And it follows, as it seems to me, that the main point is to fix first the great features of the galactic figure, not paying too much concern to the details, which are always uncertain, of doubtful ramifications. For the same reason it seems to me very desirable that all those who apply themselves to the naked-eye study of the Milky Way, so fascinating and so useful, should add to their drawings descriptions as detailed as possible.

There is no need to despair of ever arriving at a sufficient agreement. By no means. The causes of disagreement which I have just indicated have only a very limited effect. Even now, although we have only a very restricted number of drawings of the Milky Way at our disposal, its configuration can be settled, as to its major features, for a considerable portion of the zone. This is partly the result of the excellent work recently published by Mr. Backhouse ("Publications of West Hendon House Observatory, Sunderland," No. II., 1902).

The differences which he establishes between his own observations and those of other observers are often more apparent than real†; in many cases they could be easily explained and eliminated. The important matter is to be able to compare with each other *a great number* of drawings made independently. I need only refer to what Mr. Maunder has said in his book ("Astronomy without a Telescope"), as the readers of KNOWLEDGE have no doubt seen, as to the service to the science which the friends of astronomy could render even without the possession of any instrument.‡

* It is true that these six stars would not certainly produce so brilliant an effect, even for normal eyesight, if their brightness were not enhanced by the luminous background produced by the myriads of stars on which they are projected.

† In the majority of cases they are due to imperfections in the reproductions.

‡ I may perhaps be allowed to note here that "charts for inserting the Milky Way" are to be had free of expense from the Editor of *Popular Astronomy*, or from Dr. A. Pannekoek, Observatory, Leiden.

Even in the matter of details, the agreement between different observations is very often remarkable. Between the two small, very near stars, π_1 and π_2 Cygni, in the extreme north of the constellation, the luminosity becomes slightly hollow towards the south. But this little, almost insignificant, detail, which really exists—it can be seen also on the photographs—is to be found in all the descriptions and drawings that I have examined.

There is, therefore, no need to be in despair that we shall never succeed—and even soon—in depicting in a definitive manner, and in fair detail, the *status presens*, of the visible galactic phenomenon. It would be a great accomplishment, and for two reasons. First, because it is always important to record as faithfully as possible in the storehouse of our observations all that nature presents to us; it is, so to speak, the first duty of all who study nature. And we can already see of what use such a document may prove to future astronomers Is it not strange that Ptolemy in his description of the Milky Way, so comparatively exact, recorded in the 138th year of our era in "The Almagest," says nothing whatever of the bright regions in Scutum? We cannot surely admit that all this region of the Milky Way was invisible 1800 years ago; more probably the copyists have made an omission. Nevertheless, if Ptolemy's description had come down to us in greater detail and better preservation, we should be in a position to-day to affirm that the phenomenon had been invariable in its general form throughout 2000 years. It is not impossible that very slow changes in brightness have come about in the case of most of the stars situated in the same region of the sky; they could be detected by a comparison of observations made at very distant epochs of time. Ought we not therefore, now, to make an effort and devise to posterity a document for such a comparison?

But another question is raised here. These efforts to obtain a representation of the Milky Way, as it appears to the naked eye, are they not useless in view of the enormous progress of celestial photography in late years—progress that does not seem to have yet reached its term?

I believe that this objection ought not to hinder us. Certainly the gigantic eye of the telescope and the perfected "retina" of the photographic plate are admirable instruments, and in particular stellar photographs are of the highest value. But at the same time let us not be ungrateful; our eye, the simple human eye, has also its advantages. Even the imperfection of the visual organ—and this is a very interesting point—enables us to attain one thing that photography is powerless to do: the impression of the whole. It embraces and registers in a single glance, in a single instant, everything that is presented to it. The photographic plate on its side is, at first insensible, it takes time . . . only it catches up again! It accumulates slowly, during consecutive hours, during whole nights if we wish it, and in gathering up its treasures of hidden light, it exposes to us stars that the greatest telescope can scarcely reveal. . . . Only these are not, so to speak, "photographs of the Milky Way," though they are often so called. They are photographs of stellar groups, more or less numerous, *in* the Milky Way. The optical phenomenon of the Milky Way evidently cannot be rendered by a process of this nature. If finally we find forming on the plates, spots analogous to the galactic spots, they spring from other causes; partly since the appearance of such an image viewed from a certain distance produces an optical illusion to our eyes comparable to that produced by the Milky Way.

The photographic process has errors of its own. The light of a star gives rise to, not a luminous point, but a little disk, which is far from being circular, especially near the edges of the plate, and in the case of fairly bright stars this can spread, and may "eclipse" the small stars near. And if we examine such a plate carefully, especially if we compare it with other plates which have been exposed for a longer time, we often find that the small luminous spots which are to all appearance but single stars, are in reality groups of stars close together.

A more serious drawback in celestial photography is that we cannot yet succeed in obtaining anything more than a narrow degree of uniformity. This is easily explained when we consider the diversity of the instruments, the condition of the atmosphere, etc. So far it has only been possible to remedy in but an insufficient manner this important obstacle, and at least for photographs taken by different people at different times and places, it comes about sometimes that two photographs of the same celestial region present considerable differences, even where care has been taken to bring the conditions into as much accord as possible. The enthusiasm is much moderated of those who a few years ago saw in imagination observations which were entirely "mechanical"—the astronomers being henceforth relegated to their desks.

I do not wish to dwell here on the difference between the actinic light of stars which alone affects the photographic plate and the light which impresses our eyes. This difference, and the variety between the two kinds of images which result from it, is enough of itself to establish the need for visual observations.

We might even find cause for astonishment that the appearances of "photographs of the Milky Way" and of drawings should sometimes show so great a resemblance*—and it probably proceeds from the fact that for the very faint, inferior magnitudes, the great mass of the stars in the Milky Way are nearly of the same spectral type.

I have thought it useful to enter somewhat in detail into a question that seems to me of interest, especially for naked-eye observers. In conclusion, I would like to say something about the relation to each other of the optical phenomenon of the Milky Way and of the physical phenomenon—the Galaxy or the galactic system. But it is a delicate question, where it is for the moment of importance to affirm nothing and to accept results only as provisional.

What are the stars which produce the optical phenomenon?

In the first place, is there not here something beside stars? Nebulosities, sometimes brilliant ones, are shown by photography to be present in many parts of the Milky Way; do they not play in it an important *rôle*?

But there is little probability that this is so. Evidently the rays emitted by these nebulosities are extremely actinic. That means that probably they make little or no impression on our visual organ. It is even possible to make a little experiment in this matter. For this I chose a very brilliant region of the Milky Way—between α and ξ Cygni. In the small chart annexed (Fig. 1) I have traced as accurately as possible the contours of the luminous spot taken from the drawings of Heis, Houzeau, Pannekoek, Boeddicker and my own. As might be expected, the divergences are fairly great; still the tracing on the whole differs so widely from the contours of the celebrated "America Nebula" which makes this region such a brilliant one on the photographic plate (*see* Dr. Max Wolf's photograph reproduced in this number of KNOWLEDGE), that I consider it established that even this nebula does not sensibly affect the human eye.

* A comparison between Chart I. of my "Voie Lactée dans l'hemisphère boréal" and Barnard's photographs of the regions between Altair and Scutum (*Astrophysical Journal*, I.) is very instructive from this point of view.

XUM

Let us then confine ourselves to the stars. Theoretically we might assert that all stars, however minute, exercise an influence on our retina—and, consequently on the drawing—provided that they are sufficiently numerous

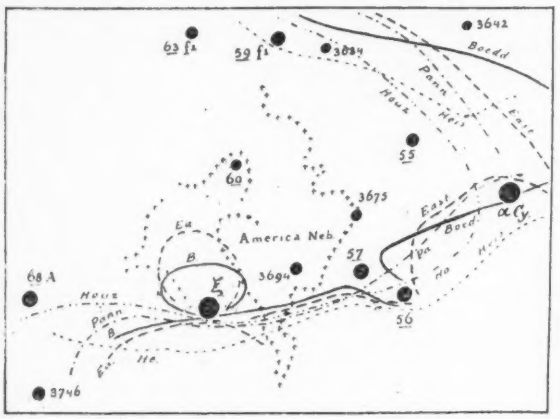


FIG. 1.—Drawings of a Galactic Spot (α—A Cygni) compared with the contours of a brilliant nebulosity. (The outlines of the drawings have been indicated by dotted lines, &c.; the form of the great nebula is indicated by little crosses. The numbers of the stars are those of Flamsteed (underlined), or of the General Catalogue.)

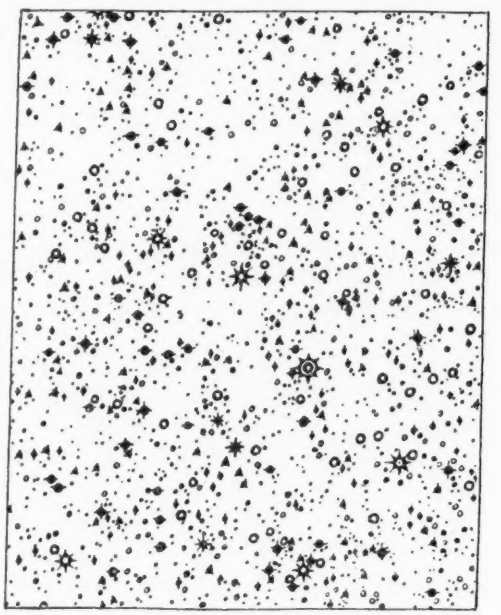
and sufficiently crowded. The stars visibly separate to the naked eye are naturally excepted. But in practice the question may be thus put: What order of brightness exercises the greatest influence?

Here, again, it is always the point to know if the stars form groups that are crowded enough. But taken in general, we can nevertheless show that the brilliant stars, at least to the 9th magnitude, do not exercise a *preponderant* influence. This was demonstrated some years ago by Plassman, by means of a chart on which he had drawn by gradations of colour a "theoretical Milky Way for Argelander's stars" (to about 9·5 magnitude), in giving naturally to the brilliant stars a greater part of the total light of a certain portion of the sky than to the faint. This chart —which was published in "Himmelskunde" (Freiberg, i., Br. 1898)—shows well a certain resemblance with the course of the Milky Way, but also considerable divergences. It is certain that these divergences are due to feebler stars than those in the Bonn Catalogue. Some time ago I tried to elucidate this question by comparing the distribution of the stars of different classes with the distribution of the galactic light in certain regions of the sky (KNOWLEDGE, August, 1895), and in a more recent paper I pushed this enquiry further.

In a very brilliant region of the Milky Way, to the south of γ Cygni (Fig. 2), I have taken a surface measuring 1° in declination and 4 minutes in right ascension (coordinates for 1855·0; $\alpha = 20h\ 2m.\ 30s.$ to $20h.\ 6m.\ 30s.$; $\delta = 36° + 37°$. A single star (25 Cygni, B.D. 3907, mag. 5·5 Arg.; 5·2 H.P.) is visible to the naked eye in this region. On a photographic plate by Prof. Max Wolf, of Heidelberg, I have observed and classified as carefully as possible all the stars included in it, drawn with their estimated magnitude. They seem joined together on the drawing*—1760 are counted, classified as follows:

Estimated Mag.		Number of Stars.		Total light produced by each class.
7·6— 8·0	...	1	...	243
8·1— 8·5	...	6	...	923
8·6— 9·0	...	6	...	584
9·1— 9·5	...	17	...	1048
9·6—10·0	...	42	...	1639
10·1—10·5	...	61	...	1509
10·6—11·0	...	103	...	1613
11·1—11·5	...	135	...	1338
11·6—12·0	...	134	...	840
12·1—12·5	...	141	...	560
12·6—13·0	...	188	...	472
13·1—13·5	...	229	...	362
13·6—14·0	...	697	...	697
Total	...	1760		11,828

These magnitudes are only estimated; they cannot be identical with Pickering's scale, for example, and the limits cannot be constant. But in any case it is clear that about half the total light (the share of each class of stars in the total light has been indicated in the last column of the table, the brightness of a star of the first class having been taken as unity) is due to the magnitudes 9·6



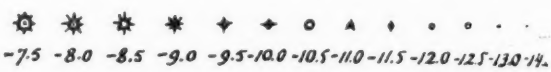


FIG. 2.—$\frac{1}{3600}$th part of the Sky: 1760 Stars.

to 11·5, or 9th to 12th, and that even large errors in the estimation do not sensibly modify this result; that neither the relatively bright telescopic stars (6th-9th mag.) nor the exceedingly feeble stars (12th-14th mag.) exercise any considerable influence in the production of the optical phenomenon of the Milky Way. A similar investigation in a region of the Milky Way much less brilliant leads to almost the same result.

* For particulars of these researches, I must refer the reader to my recent article "The Distribution of the Galactic Light, &c." in the "Verhandelingen de l'Akademie Roy. des Sciences des Pays-Bas, VIII., 3.

On the same area of the sky on which these 1760 stars are counted, there is but *one* visible to the naked eye; a short exposure gives 40. (Compare Mrs. Maunder's photograph reproduced in KNOWLEDGE, December, 1900; though, doubtless the negative would show a greater number of stars.)

If the entire sky were strewn as profusely with stars—though it is plain that is far from being so—photography would show us 90 millions of stars down to magnitude 14.

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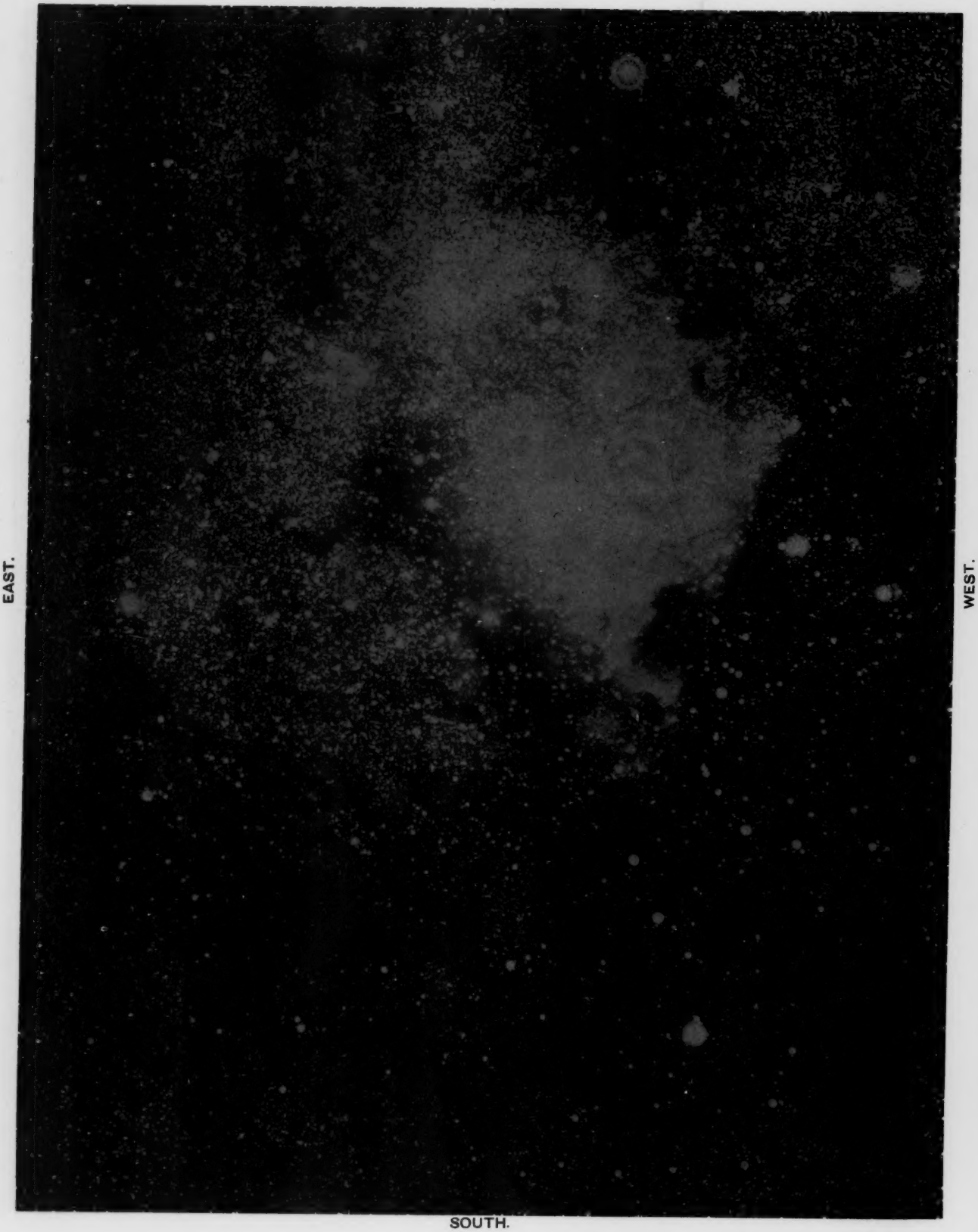
NORTH.



EAST. WEST.

SOUTH.

THE "AMERICA" NEBULA IN CYGNUS.

Photographed by Dr. Max Wolf.

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But may we conclude that it will be the same in all the other regions of the Milky Way? Here again, though we must not positively affirm anything, I am inclined to believe that more complete investigations will not lead to very materially different results. Still we already know that the distribution of different stellar classes, in this connection, is not the same for different regions of the zone. Thus, when we treat of the "relative frequency" of stars of different magnitudes as we have done above for near γ Cygni, we can say that the mean brilliancy of stars in the Milky Way approximates much more nearly to the bright classes in the northern regions near Cepheus, whilst this mean magnitude is much feebler towards the south in the regions of Aquila and Scutum. I have tried to explain in former numbers of this magazine (KNOWLEDGE, 1902, July and August) for what regions these peculiarities of distribution appear to me of the greatest interest for leading us to conclusions as to the probable distance of parts of the Milky Way.

Rotterdam.

THE SURROUNDINGS OF THE "AMERICA" NEBULA.

By DR. MAX WOLF, F.R.A.S.

PHOTOGRAPHS of this fine nebula have been published not only by myself (KNOWLEDGE, 1902) but also within the last few months by Dr. Roberts and by Professor Barnard. On these occasions, however, only the nearest surroundings have been reproduced. Owing to the great interest of this beautiful object I have prepared a reproduction of a whole plate, showing the situation of the nebula in the thick cloud of the Milky Way, which is so striking to the naked eye as we look eastward from Deneb. On this reproduction we see much better the faint nebulous matter filling the dark channels between the stars to the east and west of the "America" Nebula. The great difference in appearance between the crowds of stars and the nebulous parts is very well seen. The most interesting parts seem to be the streams and clouds at the western side of "America" between the bright stars. The reproduction is of the same size as the original plate, and is made by contact printing only, and without any retouching. Scale:—One degree = thirty-five millimetres.

Konigstuhl, Heidelberg, February, 1903.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

RARE CONDITION OF THE HUMAN HAIR.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—If one examines closely the variations of the hair on many human subjects, interesting facts frequently appear. One of these I found lately on the hands of a man aged 23, whose skin was generally very hairy. The dorsal surfaces of his hands and fingers presented, in the usual places where hairs are found, groups of black points, and among these a very few stray hairs of ordinary length. On the dorsum of the hand the black points were only seen at the radial and ulnar borders, the surface between being clothed with hair of the usual kind. When one's finger was passed over these black points, against the proper slope of hair of the part, the skin felt quite smooth. Examination with a lens showed that the black points were shafts of hairs which did not project above the epidermis. The appearance was indeed more like that of the black dots so common on other parts of the skin, and due to acne, than like the ordinary worn-down appearance of hairs, and the man said that as far as his recollection went back he had noticed the black points to be just as they are now. I may add that no similar state of the skin and hairs was to be found on the feet. This condition of the human hair is very rare, and I have never met with it before. As far as it goes it supports the view that the worn-down bristly state of the hair on the digits, so often found in man, is due to a mechanical cause, viz., constant friction of the hair against external objects, and not to any true degeneration of man's hairy covering of which this is a small part. The phenomenon noted here, dating as it does from a very early period of life, tends to show that the worn-down state of the hair was inherited.

WALTER KIDD.

SOLAR ACTIVITY AND TERRESTRIAL MAGNETISM.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In a recent contribution to the *Astrophysical Journal* (November, 1902), the writer of the same, Mr. A. L Cortie, throws doubt on the observations made by Prof. Young at Sherman in 1872, and contends that the phenomena observed by Prof. Young do not stand in the relation of cause and effect, as regards some sharp twitches of the magnetic needle, apparently synchronous with several directly observed spectroscopic disturbances. I have always attached great importance to these particular observations of Prof. Young, who, needless for me to say, is a most conscientious and careful observer. His observations not only deal with a solar disturbance and *not with a spot as such*, but they incidentally favour the idea of a *sun-located* cause. Mr. Cortie, as I understand, takes up the position that spot-areas cannot be directly expressed in values of magnetic force. From this view I think hardly anyone will be prepared to differ, but that opinion does not necessarily include the displacement from the sun of the cause of the terrestrial magnetic disturbance. At any rate, many observational reasons point the other way. These I gave your readers in a letter on this subject in the December issue of KNOWLEDGE.

On looking the matter up again in Young's "The Sun," I come to the conclusion that to label Young's observations and deductions "coincidences" is, in my humble opinion, unjustified. At the same time it must be stated that Young himself leaves the matter pretty much an open question. Mr. Cortie tells me that if I did study the curves for the days in question I should modify my opinion. I went to examine the Greenwich observations, but was unable to find a record of the curves, and must, therefore, rely on the diagram given in "The Sun" as a faithful representation of the magnetic records of the two days. And there are, on August 3rd, 1872, three distinct solar paroxysms taking place at clearly defined time-intervals, each strictly simultaneous with the mechanically recorded magnetic disturbances. The diagrams do not evince sufficient general excitement to screen in the least the three distinct jerks of the needle. Contrary to Mr. Cortie's opinion, I consider, therefore, the case just cited as much more convincing than the one which took place two days later, in the proportion of three events against one. Mr. Cortie misses the point when he says of the second case that it was nothing unusual, because it occurred at the tag end of a magnetic storm. The point is that particularly strong outbursts on the sun were directly observed at a definite time and the magnetic recording instrument responded at that precise moment by distinct and pronouncedly sharp excursions. For this reason then is the case of August 3 stronger, inasmuch as this synchronism repeated itself three times within 3½ hours.

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Let me add to the above, that Lord Kelvin's so-called theoretical proof of the sun's inability to raise a terrestrial magnetic storm has never brought a grain of conviction to my self-reliant mind, and therefore I do not feel called upon to look for electrified corpuscles outside the sun, which are credited by some as taking part in the intervention of the forces concerned. This is very much like robbing Peter to pay Paul, apart from the fact that the observational objections to which I have already referred are in no way satisfied by such and similar propositions. Be it also remembered, that one authentical case disposes of Lord Kelvin's "impossible" dictum. In my opinion, the whole process is one of "induction," and the amount of work to be done by the sun to raise a terrestrial magnetic storm is merely a question of the sun's electric potential where disturbances occur, and of electrical conductivity of the luminiferous ether between sun and earth, both utterly unknown quantities to Lord Kelvin.

ALBERT ALFRED BUSS.

9, Grosvenor Square, Ashton-on-Mersey.

CIRCULAR RAINBOWS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In reading over the correspondence in your columns on "Rainbow" in the February, September, and October numbers of KNOWLEDGE, 1901, I thought it might be worth while mentioning one thing I have noticed about rainbows while at sea, that is, that under certain conditions the rainbow is seen as a complete circle. The conditions required are, the observer should be situated on a mast or something of small diameter which does not prevent the sun from shining on the rain falling in the vicinity; he must be at least about 50 feet above the sea level; the higher he is the more brilliant will the colour appear of that part of the circle projected on the sea. But I have found that at a height of about 150 feet, the colour of the part with the sea or the deck of the ship for a background is quite as brilliant as the colour in the part projected on the clouds, which forms the rainbow to an observer at the sea level.

Then as regards the sun's altitude; if it is over 42° then the whole circle is projected on the sea. I have seen this circle where the sun had an altitude of over 75°, but then the circle crossed the vessel's deck. Of course it could be seen with the sun in the zenith, but it would be almost impossible for it to be raining and the sun to be shining in the same spot where the sun is at that altitude.

Although I have spoken of this "rainbow" as a circle, it appears as a circle only when the sun's altitude is over 42°. When the sun's altitude is less than 42°, and part is projected on the sky and part on the sea, then it appears to be an ellipse, a line drawn from the centre of the bow proper to that part of the ellipse close to the observer forming the major axis. When there has been a secondary bow visible from the deck, I have often gone aloft high enough to see the primary as a complete ellipse, but have never seen any more of the secondary bow than was visible from the deck.

In writing this I may only be repeating what has often been noticed before, but I have never seen it mentioned anywhere.

CHARLES C. DIXON.

Liverpool.

Obituary.

ANDREW AINSLIE COMMON, LL.D., F.R.S.

We much regret to announce the death of one who has done so much for astronomical science as Dr. Common, who died very suddenly at Ealing on June 2nd. He was born at Newcastle on August 7th, 1841, and eventually settled down in London as an engineer; but in addition to his business life, he devoted much time and energy to astronomy, especially to the construction of large reflecting telescopes. Early in life he possessed a $5\frac{1}{2}$-inch refractor, and in 1876 he was observing with an 18-inch reflector; but not satisfied with this, he constructed a 3-ft. equatorial reflecting telescope, with a silver-on-glass reflecting surface. A slight delay was experienced in getting this instrument to work, as the first mirror burst into fragments, but in 1879 the second mirror was successfully mounted. Recognizing the value of photography, he had already applied it to obtain records of the Pleiades and other regions, but with this increased optical power he at once turned his attention to secure impressions of nebulæ, and it was with this instrument that he obtained the splendid photograph of the Nebula in Orion, gained an astronomical reputation, and won the gold medal of the Royal Astronomical Society. Other observations with the 3-ft. enabled an error in the ephemeris of Mimas, the satellite of Saturn, to be corrected. However, with 3-feet aperture the ambition of Dr. Common was not yet reached, for in 1880 he ordered a 61-inch disc of glass, and eventually successfully completed his 5-ft. reflector, which perhaps, with a newly-silvered mirror, is the most light-grasping instrument ever constructed, and although it never established the record that the smaller obtained, and has again recently secured at the Lick Observatory, yet it is doubtful if some of the unpublished photographs of Jupiter and Saturn taken with it have been surpassed.

Space will not permit mention of more than a few of the mechanical difficulties he overcame in these mammoth instruments—the successful silvering of large mirrors, the floating of the polar axis to reduce friction, and the slipping plate to correct clock irregularities.

He was elected a Fellow of the Royal Astronomical Society in 1876, and of the Royal Society in 1885, and was President of the former Society in 1895-6. He was an honorary LL.D. of St. Andrews, and filled many offices in connection with astronomy.

Of late years his energies had been largely devoted to the application of the telescope to gun-sighting, and he was so successful that the War Office and Admiralty had adopted his gun-sighting telescope. He had many other improvements in sighting apparatus in contemplation, and his death is not only a loss to the astronomical world, but to the nation.

Notes.

ASTRONOMICAL.—Prof. Barnard has recently published a very interesting account of observations of the south polar cap of Mars which he made at the Lick Observatory in 1892 and 1894. He considers the early supposition that the caps are accumulations of snow to be as good as any theory since put forward, and points out that they cannot be of any great depth or they would not be melted so quickly; they are probably a thin sheeting corresponding with the winter snow which extends to our own mid-latitudes and quickly disappears with the approach of summer. On some occasions portions of the cap were temporarily hidden, and there was good reason to suppose that the obscuration was produced by something of the nature of clouds, though the atmosphere seems to be much less dense than our own. The most striking phenomenon, however, was a projection from the edge of the cap, visible at the same point in both years, which was left behind as a bright strip as the cap diminished in size. This is probably a range of mountains, and was found to

have been previously observed by Mitchell in 1845, and also by Green, who gave the same explanation.

A series of very interesting photographs has been secured by Mr. H. K. Palmer with a slitless spectroscope specially designed for use with the Crossley reflector of the Lick Observatory. Among them are spectra of planetary nebulæ and Wolf-Rayet stars, but the most important are those of bygone "new stars." Nova Aurigæ, in 1901, when its visual magnitude was 13, showed four bright lines, and a comparison with earlier records shows plainly that the bright lines are growing weaker as compared with the continuous spectrum. Nova Cygni (1876), now about 15th magnitude, seems to have completely lost its nebular characteristics, the spectrum having become continuous. Mr. Palmer thinks it will now be possible to photograph the spectrum of any star that can be seen with the 36-inch telescope.—A. F.

BOTANICAL.—Visitors to Kew Gardens during the past few weeks may have noticed in the Succulent House some tall plants, having pinnatisect leaves, with long stiletto-shaped segments, and large terminal heads of bright pink flowers. This is a hybrid *Kalanchoe*, known as *K. kewensis*. In the March number of the *Annals of Botany* Sir W. T. Thiselton-Dyer made it the subject of one of his interesting "Morphological Notes." The hybrid originated at Kew, and besides being a beautiful plant of considerable horticultural value, it is remarkable in being a striking exception to the rule that a hybrid exhibits characters intermediate between those of the parents. The species from which the new hybrid was derived are the South Arabian *K. Bentii* and *K. flammea*, from Somaliland; the former has long entire stiletto-shaped leaves and white flowers, while in the latter the leaves are obovate or obovate-oblong, and the flowers orange-red. In the hybrid the leaves are not intermediate, but they approach in shape two other species of *Kalanchoe*, and, as the author observes, "the conclusion seems irresistible that we have a reversion to an ancestral character which exists elsewhere in the genus, but is latent in both parents." The deviation in the colour of the flowers is more easily accounted for. It is shown that in one parent the flowers have deep yellow chromoplasts in a pink cell-sap; in the other both chromoplasts and cell-sap are colourless. The hybrid, it is believed, has inherited the pink cell-sap of one parent and the colourless chromoplasts of the other.—S. A. S.

ENTOMOLOGICAL.—In KNOWLEDGE for September, 1901, there appeared an account of Flies and Midges that haunt the sea-shore. In a recent paper (*Arch. Zool. Exper. et Gen.* (4), Vol. 1, 1903, pp. 1-29, pl. 1), M. René Chevrel describes a very interesting new marine midge, which he has discovered at Saint-Briac (not far from St. Malo in Brittany), and named *Scopelodromus isemerinus*. Both sexes of this midge are winged, and possess short feelers with only seven segments. The larva lives among seaweeds and barnacles below the usual low-water mark, and, as the life-cycle of the insects occupies six months, the midges are only seen on the wing twice a year at the time of the equinoctial spring tides. It is no wonder, therefore, that they have remained unobserved for so long.

Meanwhile Mr. A. D. Imms records (*Trans. Liverpool Biol. Soc.*, Vol. XVII., 1903, pp. 81-6) the occurrence on the coast of the Isle of Man of *Clunio bicolor*, Kieffer, described a year or two ago from the French shores of the Channel. The presence of a second species of this most remarkable genus in the British Isles is noteworthy. Like *C. marinus*, Haliday (described in KNOWLEDGE, September, 1901), *C. bicolor* has a wingless female.

Parental care among insects is always a subject fascinating to naturalists, and a short paper by Mr. G. W. Kirkaldy (*Entomologist*, Vol. XXXVI., 1903, pp. 113-120) on "Maternal Solicitude in Rhynchota and other non-social Insects," with a full bibliography, is worthy of attention from all interested in the beginnings of family life among animals. Good evidence is brought forward for watchful care exercised by mother Saw-flies and Shield-bugs (*Pentatomidæ*) over their eggs and newly-hatched young, and Mr. Kirkaldy shows that the doubt thrown by Fâbre on the observations of DeGeer and others of maternal care among Shield-bugs is unwarranted, he having examined bugs of genera distinct from those upon which DeGeer's researches were made.—G. H. C.

ZOOLOGICAL.—In an article published in our columns a few years ago, Mr. Lydekker drew attention to the evidence in favour of an Asiatic origin for the aborigines of Australia, whose nearest relatives then appeared to be the Veddas of Ceylon. In a letter from Macassar (*Globus*, May 7th), the Messrs. Sarasin, who are travelling in Celebes, announce the discovery in the mountains of that island of a primitive people—the Toala—presenting a remarkably physical resemblance to the Veddas. Although these people have now, for the most part at any rate, been considerably influenced in the mode of life by contact with the Buginese of the coast districts, there is decisive evidence that a short time ago they were cave-dwellers (as indeed are some of their number now), while within a century or so ago they were in the habit of using chipped stone arrow-heads and other weapons and implements. There can be little doubt that the Toala were the primitive inhabitants of Celebes, and that they were driven to take refuge in the mountains by the Malay invaders, with whom, however, they now hold a certain amount of intercourse. Assuming their affinity to the Veddas to be true, and it is scarcely likely that such a remarkable resemblance can be merely accidental, we have much stronger evidence than before as to the probable Asiatic origin of the Australian aborigines.

It is a common belief among both whalers and naturalists that when whales "sound," they descend to enormous depths in the ocean. Dr. W. Kükenthal estimates, for instance, that the larger members of the group commonly dive to a depth of fully a thousand yards; although the evidence on which this estimate rests is not given. In a memoir recently published in Belgium, on the scientific results of the Belgian Antarctic Expedition of 1897–99, Dr. Racovitza challenges this belief, and states that, in his opinion, one hundred yards is the maximum depth to which any whale can dive, and that many species cannot reach anything like that limit. He very pertinently asks why should whales want to go to such depths. All whales sound for the purpose of obtaining food; and in the profound darkness of one thousand yards what food could they get? Those species which feed on animalcules might perhaps obtain what they want. But how about the species which feed on fishes and cuttles? At a depth of a thousand yards they certainly could not use their eyes to detect non-luminous species, and we have no evidence whatever that they feed on the self-luminous deep sea fish and cuttles (if indeed there be any of the latter). On the contrary, the available evidence indicates that they feed on ordinary light-dwelling fishes and cuttles which live in much shallower zones.

But this is not all. It is known that the effects of a pressure of more than three atmospheres proves fatal to human life, and although we may believe that whales can stand treble this pressure, or nine atmospheres, which

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would occur at about ninety yards depth, is it conceivable that they could resist the effect of ten times the latter pressure, or ninety atmospheres? Moreover, does it seem possible that a whale, whose body is only slightly heavier than water at ordinary pressure, could exert the muscular force necessary to propel that body to a depth of a thousand yards?

Whether the author has so strong a case in his contention that whales never sleep, demands further consideration. One of the arguments in favour of the constant wakefulness of cetaceans is that individuals will follow a ship for days, which they could not well do while asleep. Another is that whales—except occasionally a right whale or a sperm whale—are not found floating motionless on the surface, and reasons are given against the theory that they sleep at the bottom. But, it may be urged, if whales never sleep, they must have food at night, and be able to catch it, and what then becomes of the argument that they cannot capture prey in the dark ocean abysses? Moreover, it is difficult to imagine that an animal with such a highly organised brain as a whale can exist permanently without sleeping, especially when we remember that fishes sleep.

A very important work on the morphology of the mammalian brain—especially that of lemurs, both recent and fossil—has appeared in the *Transactions* of the Linnæan Society. The author, Dr. G. Elliot Smith, has for several years devoted special attention to this subject, and in this memoir summarises the general results of his investigations. One point was the determination of the fundamental plan of mammalian brain-structure; a task of very great difficulty owing to the maze of convolutions of various types which have been superadded in the different orders. Especial interest attaches to the author's conclusions with regard to the affinities of the lemurs. The intimate connection between these animals and the monkeys and apes indicated by palæontological discoveries in Madagascar is fully borne out by Dr. Smith's investigations. It appears, however, that while the lemurs originally advanced a considerable distance along the general line of evolution of the Primates, they subsequently degraded; a fact which accounts for the wide divergence of the modern representatives of the two groups.

The restoration of a most extraordinary reptile—namely *Embolophorus dollovianus*, from the Permian strata of Texas—is attempted by Mr. E. C. Case in the February number of the *Journal of Geology*. The peculiarity of the creature is that the vertebræ carry very tall vertical spines, which in the middle of the back are equal in length to the entire trunk, and nearly double the height from the ground to the back-bone. That this bony framework carried a thin covering of skin, and was thus something like an enormous back-fin, may be considered certain; but the use of such a remarkable structure has yet to be explained.

In the April number of the *Proceedings* of the Zoological Society the Revd. F. Jourdain draws attention to the circumstance that the second instance of the occurrence of Bechstein's bat (*Myotis bechsteini*) in Britain was recorded in the *Zoologist* for 1888, on the evidence of a capture in the New Forest in 1886. Consequently the announcement made in the *P. Z. S.* for 1901 of the *second* occurrence of the species in Britain should really have been the *third*.

In a recent issue of the *Annals and Magazine of Natural History* Mr. G. A. Boulenger adduces reasons to show that flat fishes, instead of being allies of the cod family, are really related to the John Dory. From the shape of the latter fish this is a much more probable supposition.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Ornithological Notes for Norfolk for 1902, with References to some Occurrences in other Counties. By J. H. Gurney, F.Z.S. (*Zoologist*, April, 1903, pp. 121–138).—Mr. Gurney here gives his usual yearly interesting notes on the birds of East Anglia. The autumn of 1902 seems to have been chiefly remarkable for a large migration of Rooks throughout October. The following rarities were recorded from Norfolk during the year, viz.: Scops Owl—April; Roseate Tern—May and June; Caspian Tern—July; Roller, Aquatic Warbler, and Barred Warbler—September; Lesser Grey Shrike and Porphyris—October; Glossy Ibis—November; and Little Bustard—December. Mr. Gurney can unfortunately give us no good account of the Great Bustards which were imported and turned down in Norfolk in 1900.

On the Position occupied by the Legs of Birds during Flight. By G. E. H. Barrett-Hamilton (*Zoologist*, April, 1903, pp. 139–149).—It appears from this interesting article that whereas most passerine birds carry their legs bent forward in flight, other birds carry them pointing backwards, while some birds such as Kites and Gulls and certain Hawks, have the power of varying the position of their legs without interfering with their flight. Capt. Barrett-Hamilton is of opinion that in many birds, and especially in those with short tails, the legs are of great and constant assistance in flight.

The Birds of N.W. Wales and the opposite Counties of Ireland. By H. E. Forrest (*Zoologist*, May, 1903, pp. 176–181).—Mr. Forrest here compares the avifauna of Merioneth, Carnarvon and Anglesey to that of Dublin and Wicklow. The result is that most of the summer migrants occurring in Wales are very rare or absent from Ireland, while the resident birds are also very different in the two areas. For instance, the Marsh Tit, Nuthatch and Tawny Owl, although common in the Welsh counties are unknown in Ireland, and the Sparrow, Carrion Crow, Spotted Woodpecker and Green Woodpecker are of rare occurrence in the Irish counties. On the other hand the Siskin, Crossbill and Hooded Crow are more common in Ireland.

The Status of the Goldfinch in Britain (Zoologist, April, 1903, p. 152; May, 1903, p. 190).—Observers from various counties here continue to record their observations upon the status of the Goldfinch.

On the Variation of the Bean Goose. By Einar Lönnberg, C.M.Z.S. (*Zoologist*, May, 1903, pp. 164–169).—In this article the author details his examination of a number of specimens of the Bean Goose, and gives evidence for the conclusion that the characters used by Mr. Frohawk (*see* KNOWLEDGE, 1902, p. 254) are too variable to warrant the separation of the Bean Goose into two species (*Anser segetum* and *A. arvensis*).

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, *326, High Holborn, London.*

Notices of Books.

"A MANUAL OF PALÆARCTIC BIRDS." By H. E. Dresser, F.L.S., F.Z.S. Part I. Published by the Author at 3, Hanover Square, W. 12s. 6d. net.—This is the first part of a work long expected by ornithologists. The second and concluding part, we believe, is to be published very shortly. The work is practically an abridgment of Mr. Dresser's well-known "Birds of Europe." It is very conveniently arranged, and much information is given in a very small space. After a brief synonomy a description of the species is given, and in this Mr. Dresser has been wise in giving as far as possible the points in which one species differs from its nearest ally rather than a long and detailed description. We are then given the range of the species, and a few words about its habits and nest and eggs. The book will be found to be very useful to ornithologists, and especially to those that travel, but Mr. Dresser seems to have relied to a great extent on his excellent work in the "Birds of Europe," and has not brought his present Manual consistently up to date. The range of the various species dealt with is thus sometimes rather incomplete, and although Mr. Dresser has admitted many sub-species, he has also omitted many which, in our opinion, are as qualified to rank as distinct races as many of those which he has admitted (*e.g.*, *Prinia gracilis lepida*, *Argya buttoni*, *Parus lugubris dubius*).

But Mr. Dresser's Manual is not intended for the systematist. To the traveller it will certainly be of much use, although we wish that the author had directed attention to many more geographical variations than he has done.

"THE JOURNAL OF THE QUEKETT MICROSCOPICAL CLUB," April, 1903. (Published by Williams & Norgate, 14, Henrietta Street, Covent Garden, W.C.)—This journal is published bi-annually, and contains the proceedings of this popular Microscopical Club, which meets at 20, Hanover Square, on the first and third Fridays in each month. This Club has always been particularly strong in entomological and pond-life work, and several of the papers—which are admirably illustrated—deal with aspects of these subjects. Special interest attaches to the annual address of Mr. George Massee, F.L.S., V.M.H., the president of the Club, on "Fermentation and Putrefaction," on which, and allied subjects, he is a distinguished authority. In addition, there are reviews of certain books on microscopy. Those microscopists who may not be members of the Quekett Club would certainly find many items of interest and value in this admirably-conducted journal.

"JOURNAL OF THE ANTHROPOLOGICAL INSTITUTE FOR 1902."—We have been favoured with a copy of this journal (Vol. XXXII.) for the second half of 1902. It commences with the Huxley Lecture, in which Dr. D. J. Cunningham discourses on "right-handedness and left-brainedness" in man. Physiological experiments have shown that a certain area on each side of the brain is connected in some way or other with regulating the movements of the arms; the left side of the brain controlling the right arm, and *vice versâ*. This being so, it was natural to expect, in correlation with the general prevalence of right-handedness in man, that the left "arm-area" of the brain would be more developed than the right. The author has found that a certain depression in this area is deeper on the left than on the right side. That this is in any way associated with right-handedness, or with the localisation of the active speech centre in the left side of the brain, he is, however, not prepared to urge, because the same condition obtains in apes. This would be no impediment to the acceptance of the explanation by those who believe that apes are also right-handed; but Dr. Cunningham cannot persuade himself that those animals are really dextrorsal. Nevertheless, he is convinced that he is on the true track to explain the prevalence of right-handedness in man. In the course of his lecture the author mentions that he sees no reason to believe in the absence of right-handedness in pre-historic man owing to a preference for drawing animals with their heads turned in one direction. In this connection it may be mentioned that the author persists in the old error of calling the bison the aurochs.

Among many other interesting articles, we have only space to refer to the one by Messrs. Annandale and Robinson on the anthropology of the Malay Peninsula, which is illustrated with photos of that puzzling race, the Semangs of Perak. The authors believe that Semangs and Sakais contain a Mongoloid element distinct from that of the modern peninsular Malays; but, unfortunately, they do not favour us with any definite opinion as to the Negrito affinities of these people, as indicated by the frequent occurrence of more or less distinctly frizzled hair.

"HANDBOOK OF CLIMATOLOGY." By Dr. Julius Hann. Translated by Robert De Courcy Ward. (Macmillan.) 12s. 6d. net.—It is commonly said that meteorology consists of volumes and tables of uninteresting figures that only experts can understand. It is further complained that few attempts are made to discover the inner meaning of the accumulated observations with which the shelves of most weather offices are congested. In this book, however, a notable and successful attempt has been made to put life and meaning into some of these arid statistics; and it may at once be said that the result is one of the most interesting books that the subject of climate has so far inspired. The book treats of climate as distinguished from weather, for nowadays the two terms are differentiated. Dr. Hann calls weather only one phase in the succession of phenomena whose complete cycle, recurring with greater or less uniformity every year, constitutes the climate of any locality. Climate is the sum total of the weather as usually experienced during a longer or shorter period at any given season, and it is with this latter branch of meteorology that Dr. Hann deals. Certain changes have been made by the translator in this English edition of Dr. Hann's book, which was originally published in 1883 under the title of "Handbuch der Klimatologie," but they are changes that have greatly increased the usefulness of the work. The book has been especially arranged for the use of teachers of scientific climatology, and as it contains ample references to other works on the same subject, and also a very convenient classification of the different sections and chapters, a teacher with it at his hand should have little difficulty in arranging a useful course of study. Since the teaching of meteorology has been much neglected in British schools, such a publication should stimulate an interest in the subject. Probably the most informing section will be considered by many readers to be that which deals with mountain climates. This subject is treated exhaustively in a discussion that no one who desires to know the lines of investigation followed by modern meteorologists in this very important branch of climatology can afford to overlook. The thanks of those who do not read German are due to Mr. Ward for so ably translating the book for them, and it is to be hoped that he will find an early opportunity of introducing English readers to more of the same author's works.

THE BURLINGTON MAGAZINE for June contains an admirable editorial appeal for the preservation of ancient buildings by the State. The recent sale of Clifford's Inn has brought this question once more to the front, and we gladly associate ourselves with the Editor's appeal to the London County Council to acquire Clifford's Inn from its new owner while there is yet opportunity to do so. But the question is really one for His Majesty's Government, and we hope some Member of Parliament may be induced to make it his own, and remove the reproach that we share at present with Russia and Turkey, of being without any legislation for the preservation of our ancient historical buildings.

BOOKS RECEIVED.

Mathematical Crystallography and the Theory of Groups of Movements. By Harold Hilton, M.A. (Oxford: Clarendon Press.) Illustrated. 14s. net.

Among the Night People. By Clara Dillingham Pierson. Illustrated by F. C. Gordon. (Murray.) 5s.

The Religious Sense in its Scientific Aspect. By Greville MacDonald, M.D. (Hodder & Stoughton.) 3s. 6d.

Central Europe. By Joseph Partsch, PH.D. (Heinemann.)

Growth and Direction of our Foreign Trade in Coal during the last Half Century. By D. A. Thomas, M.P. (Royal Statistical Society.)

Smithsonian Physical Tables. By Thomas Gray. (Washington: Smithsonian Institution.)

Superstition, Magic, and Medicine. By Walter E. Roth, B.A., M.R.C.S. (Brisbane: G. A. Vaughan, William Street.)

Radiant Energy. By R. W. O. Kestel. (F. Cockington, 3, Mentone Road, N.) 2s.

The Service of Man. By Cotter Morison. (Watts.) 6d.

Watkins' Manual. (Hereford: Watkins' Meter Co.) 1s. net.

Adventures of Lyderic, Count of Flanders. By Alexandre Dumas. (Gowans & Gray.) 6d. net.

Field Studies in Natural History: Programme of Summer Rambles, 1903. (Essex County Education Committee.)

Commerce of Latin America. (Philadelphia Commercial Museum.)

Subject List of Works on Architecture and Building Construction in the Library of the Patent Office.

Report of the Committee on Mathematic Science for 1902. (Washington: Philosophical Society.)

"Via Indo" Telegraphic Social Code. Compiled by Robert T. Atkinson. (Via Eastern Code Company, Limited.) 5s. net.

Conférence Astrophotographique Internationale de Juillet, 1900. (Institut de France, Académie des Sciences.)

Variation in the Milk of a Dairy Herd. By T. S. Dymond, F.I.C., and B. W. Bull, N.D.A. (Essex Education Committee.)

Notes from the Royal Botanic Garden, Edinburgh, 1901. (Edinburgh: Oliver & Boyd.) 9d.

Veterinary Journal, June, 1903. 1s. net.

Astrophysical Journal, May, 1903. $4.

Scientific Roll, May, 1903. 1s.

Technical Arithmetic and Geometry. By C. T. Millis, M.I.M.E. (Methuen.) 3s. 6d.

A Junior Geometry. By Noel S. Lydon. (Methuen.) 2s.

The Cloud World: Its Features and Significance. By Samuel Barber. (Elliot Stock.) 7s. 6d.

The Year Book of Photography and Amateur's Guide, 1903. (*Photographic News* Offices.) 1s. net.

Catalogue of Photographic Apparatus and Materials. (City Sale and Exchange, Fleet Street.)

Booklet on "Tabloid" Photographic Chemicals. (Burroughs, Wellcome & Co.) Free.

XUM

"MOLECULES AND HEAT."*—A CRITICISM.

By EDWIN EDSER, A.R.C.Sc., F.PH.S.

As the result of experiments carried on for a number of years, Mr. Hovenden claims that molecules can easily be seen by the unaided eye. Nothing could well be more startling than such a claim; it is proposed to examine briefly the grounds on which it is based. It may at once be said that Mr. Hovenden is perfectly honest in the statement of his case, and some of his experiments are worth repeating. Further, for an untrained observer, he sometimes notes the essential conditions of a phenomenon with commendable sagacity, although his explanations, as will be shown, are often of a very partial character. Personally, I have to thank Mr. Hovenden for his courtesy in showing me a number of his experiments, and explaining his views thereon.

Let us take a thin glass flask partially filled with a liquid, such as water, spirits of wine, &c., and focus the rays from an arc lamp at a short distance above the surface of the liquid. After gentle heating, a large number of small spherical bodies are seen floating about in the space above the liquid. Mr. Hovenden claims that these small spherical bodies are molecules of the liquid; he further defines a water molecule as a spherical body composed of *a great number* of atoms of oxygen and hydrogen in the proportion of one of the former to two of the latter. At first sight, therefore, it would appear that a water molecule, as defined by Mr. Hovenden, is indistinguishable from a small drop of water composed of a great number of the generally accepted molecules, each comprising one atom of oxygen and two atoms of hydrogen. Mr. Hovenden has, however, been struck by the fact that whereas a small drop of water, when cast up from the surface of the boiling liquid, is seen to quickly fall back again, yet the small particles mentioned above exhibit no observable tendency to gravitate, but slowly circulate, in swirls and eddies, in the space above the liquid. The accepted explanation of this depends on the fact that a gas or liquid exerts considerable friction on very small particles, which are thus unable to sink quickly; for similar reasons, muddy water clears very slowly when at rest, and more slowly still when in motion. We may, however, for the moment forget this, and consider Mr. Hovenden's explanation, which is that the small particles seen floating above the liquid were invisibly small when within the liquid, but during heating they absorbed the ether (which is supposed to be an anti-gravitating fluid), and expanded to visible dimensions, at the same time acquiring anti-gravitative properties. Mr. Hovenden has noticed that these particles are only to be seen when there is cold air in the flask. To most observers this would suggest that their presence demands conditions favourable to condensation. Mr. Hovenden, however, proposes the explanation that, when cold air is not present, the particles become invisible, just as finely-divided glass particles, which form a white flour-like powder in air, become almost invisible when mixed with water. When the liquid is caused to boil, and air is expelled from the flask by the vapour given off, the space above the liquid appears absolutely empty. "But," says Mr. Hovenden, "the flask is full of these spheres, for they issue out of the flask as steam." This is begging the question. The particles may truly be seen leaving the mouth of the flask, but this is perfectly consistent with the orthodox explanation that the interior of the flask is filled with aqueous vapour, the invisibly small molecules of which are comparatively widely separated from each other. At the mouth of the flask the vapour mixes with the cold dust-laden air of the room, and condenses into small water droplets.

Mr. Hovenden also fills spirit lamps with various liquids and concentrates the electric light on the wicks. In each case a stream of small particles is seen rising from the wick into the air, and these particles are claimed to be molecules. If the lamp is filled with methylated spirit, the stream of particles leaving the wick becomes bright, almost resembling a flame. This experiment is a very pretty one, and might be found useful to teachers, as showing the effects produced by the absorption of radiations. Mr. Hovenden's most striking experiment, however, consists in lighting the spirit lamp and placing the *flame* in the focus of the electric light. Particles, similar to those formerly described, but much less numerous, are seen in the interior of the flame, and Mr. Hovenden claims that in this case condensation is necessarily eliminated. Careful examination shows that the particles are visible only near the boundary between the luminous mantle of the flame and the non-luminous central core. This core is known to be cold, so that once more we have the conditions that the particles are formed only where the heated vapours have the opportunity of becoming cooled. It may be admitted that condensation occurring under the above is somewhat surprising, and Mr. Hovenden's observation is certainly of considerable interest.

I cannot see that Mr. Hovenden has given us any experimental proof that the particles seen in the above experiments are molecules, and not small droplets of condensed liquid. To disprove the theory which he proposes, it is only necessary to compare his fundamental conception with the results of experiments. He considers that a solid consists of invisibly small spherical molecules, in contact with each other. When the solid is heated, each molecule absorbs "ether," and expands as a soap bubble does when air is forced into it. This absorption of ether, and the consequent expansion of each molecule is considered to be essential to a rise of temperature. Of course such a theory labours under all the difficulties that beset the old caloric theory; indeed, writing "caloric" instead of "ether," in Mr. Hovenden's theory, we go back to the opinions of the early part of the nineteenth century, and Davy's experiments appear to disprove one as conclusively as the others. But Mr. Hovenden's theory can be disproved on other grounds.

If a rise of temperature is necessarily connected with an expansion of the molecules of a body, then *all* substances must expand when heated. Now a piece of glass rod, when heated to redness, expands so much that, on plunging it into cold water, it is shivered to fragments by the sudden contraction. So far facts are in accordance with Mr. Hovenden's theory. But a rod of fused quartz (more strictly speaking, fused silica) can be heated to a white heat, and then plunged into liquid air without the slightest danger, or any signs of an appreciable change of dimensions occurring. It can scarcely be claimed that, during these operations, the temperature of the fused silica does not alter; heat certainly leaves the rod when it is plunged into the liquid air, and causes the latter to boil violently. On the other hand, experiment shows that during cooling, a slight contraction which occurs at one stage is compensated for by a slight expansion at another stage, so that at the low temperature the dimensions of the rod are the same as at the higher temperature. If the molecules are in contact, it also follows that the dimensions of a molecule are the same at the low as at the high temperature. Thus a change of dimensions does not always occur when a body is heated.

If further evidence were needed, we might instance the contraction of water as it is heated from 0° C. to 4° C.

Mr. Hovenden has further attempted to explain the heat of chemical reactions in terms of his theory. When

* "On Resolving the Molecule and Seeing It." "What is Heat?: A Peep into Nature's Most Hidden Secrets." By Frederick Hovenden, F.L.S., F.G.S., F.R.M.S.

hydrogen and oxygen combine to form water, the volume of the latter is less than that of the gases, and it is assumed that the atoms shrink, expelling the ether (or heat) from their interiors. From this instance Mr. Hovenden generalizes, and obtains the law that when two substances combine to form another substance, the original volumes of the constituents being together greater than the volume of the product, ether is expelled, producing a rise of temperature; when the original volumes of the constituents were together less than the volume of the product, ether is absorbed, and the surroundings are cooled. In some cases where the reaction occurs in air, and the results are not those anticipated, it is claimed that the air molecules are squeezed or expanded, as the case may be. It is, however, easy to disprove this theory, in a manner that leaves no loophole for escape. Take a cubic centimetre of gunpowder, place it in a strong steel cylinder of (say) 1000 cubic centimetres capacity, and thoroughly exhaust the cylinder. On exploding the gunpowder the constituents, which originally occupied a volume of 1 c.c, now occupy a volume of 1000 c.c., so that, on Mr. Hovenden's theory, each atom has expanded to 1000 times its original volume. Nevertheless, the resultant gases are found to be heated. The heat (or ether) absorbed by the atoms cannot have been taken from the cylinder, since the latter is certainly no cooler than before. Where, then, has it come from?

Thus we see that, starting from phenomena which anyone may observe, Mr. Hovenden has reached conclusions which, far from possessing an advantage over the accepted theories, are positively at variance with well-known phenomena. In criticising Mr. Hovenden's views, it has been found unnecessary to appeal to any other theory, except to show that the phenomena observed are capable of an independent explanation. As a result, it appears that if we possessed no physical theories at all, and were offered the above theory by Mr. Hovenden, we should be logically forced to reject it as inconsistent with itself, and with the greater part of our experimental knowledge.

FAMILIAR BRITISH WILD FLOWERS AND THEIR ALLIES.

By R. LLOYD PRAEGER, B.A.

IV.—THE COMPOSITÆ.

THE *Compositæ* form the largest Natural Order of flowering plants found upon the globe. About one-tenth of the whole phanerogamic flora may be referred to this group. They are of world-wide distribution, though their number varies largely in different countries. Thus Humboldt estimates that they form one-half of the phanerogamic flora of the tropical regions of America, and Presl states the same for Sicily; on the other hand, they formed only one twenty-third of the collections of plants made by Smith in West Africa near the Congo. In the British Isles they form about one-tenth to one-twelfth of the flora, the uncertainty as to exact proportion arising from the difference in the treatment which botanists accord to the hundred and more British "species" of Hawkweeds.

The character by which these plants are most readily recognized, and from which they derive their name, is the grouping of their flowers into dense, usually flattish, heads, surrounded by a ring of small leaves which fulfil the function of the sepals of an ordinary flower. In my last article, we saw how in the *Umbelliferæ* the numerous small flowers are gathered together, so that the whole forms a most conspicuous inflorescence; but in these plants each flower is stalked, and each group of flowers (umbellule) usually is again stalked; whereas in the *Compositæ* the flowers are unstalked (sessile), and are seated tightly on the flattened top of the flower-stem (receptacle). A much closer approach to the *Compositæ* we may study in the Scabious family (*Dipsaceæ*), of which the Devil's-bit (*Scabiosa succisa*) and Teasel (*Dipsacus sylvestris*) are familiar examples. Here, as in the *Compositæ*, the flowers are sessile and set on a swollen receptacle, and surrounded by an involucre of small leaves. From this nearly related Order, *Compositæ* may be readily distinguished by the stamens, of which the anthers join together to form a ring round the style; and by the erect, not pendulous, ovule. That the flower-form of the *Compositæ* is an eminently efficient form would appear from the vast number of its species, and from the immense profusion of individuals—in our own country, of the Daisy and Dandelion, for instance. And truly, these flower-heads strike one as being in the highest degree efficient. Examine a common Daisy. The yellow button-like *disk* is composed of a myriad of small perfect flowers, with yellow five-cleft tubular corolla, and ring of fused stamens surrounding the pistil. Of calyx we find hardly a trace; the close packing of the flowers leaves no room for it, and renders it unnecessary as a protective structure. In the *Compositæ* the calyx is usually reduced to a few hairs, which often play a valuable part in aiding seed-dispersal, as we shall see, by growing as the fruit ripens into a feathery plume or *pappus*, which acts as a parachute. The marginal or *ray* flowers of our Daisy have no stamens—are female; and their corolla is white, and greatly expanded in an outward direction—the only direction in which there is room for expansion. These ray-flowers, in fact, are largely useful in *advertising* the otherwise inconspicuous flower-head. Similar devices we have already noted in the wild Guelder-rose; and we may compare with these such flower-heads as those of the little Cornel (*Cornus suecica*) and the Astrantias, in which the flowers are surrounded by a ring of coloured *leaves*, which serve the same purpose. Finally, our Daisy head is surrounded by a close-fitting double ring of small leaves, the *involucre*, which encloses the whole in bud, and plays the part that a calyx usually plays in a single flower.

FIG. 1. — Ray-flower and disk-flower of the Daisy (enlarged).

This vast Order may be divided into several well-marked groups. The *Corymbiferæ* include the genera which, like the Daisy, have a disk and a ray, and other rayless allied forms; the *Cynarocephaleæ*, which include all the Thistle-like forms, have the style swollen, and no ray; the *Ligulifloræ*, which form the best-marked group, have all the flowers *ligulate* (or shaped like the ray-flowers of the Daisy), as the Dandelion; while the *Labiatifloræ* include a few foreign genera, mainly South American, in which corolla of the central florets is two-lipped.

The *Compositæ* yield us some of our handsomest garden plants, such as Chrysanthemums, Dahlias and "Cinerarias," the latter being cultivated varieties of species of *Senecio*, introduced from the Canary Islands; also the Sunflowers and their allies, Asters, and various kinds of "Everlasting." Among vegetables, the best known are Jerusalem Artichokes (the tubers of *Helianthus tuberosus*), and Artichokes (the receptacles and involucral scales of *Cynara Scolymus*). Many species are aromatic, astringent, or narcotic, but for so vast a number of plants, comparatively few are used by man.

To sketch even the comparatively few British representatives of the *Compositæ* within the limits of a single article were an impossible task. The list of *Compositæ* in

the "London Catalogue of British Plants" numbers 234 species—though it must at once be pointed out that this total includes no less than 104 "species" of that perplexing genus, *Hieracium* (Hawkweed); if we wish to institute comparisons, this 104 species must be reduced to say ten to twenty leading forms. Even with such a reduction, the British *Compositæ* are still sufficiently numerous, and offer a wide diversity of plant-forms; but certain limitations may be noted with regard to them. Firstly, all are herbaceous; among the many British species neither tree nor shrub is found. And secondly, despite the great variety of habitat which they effect, all are terrestrial forms; some few may be found in wet marshes, but none are aquatic. For the rest, they occur in all situations, from salt marshes on the coast to the tops of the highest mountains, and they assume all forms, from tiny annuals to great perennials like the Butter-bur, with leaves which may attain six feet in height.

We have already referred to the three sections into which our species may conveniently be divided, exemplified respectively by the Daisy, Thistle, and Dandelion. Let us now glance more particularly into the native species which fall under each of these groups, and note their more prominent features. The Daisy group, or *Corymbiferæ*, includes not only all the Daisy-like flowers, with a disk or centre of close-set perfect blossoms, and a ray or margin of flowers with a corolla prolonged into a conspicuous flattened limb, often of a different colour to that of the disk-flowers; but also a number of species without the showy ray, such as Butter-bur (*Petasites*), the pretty Cudweed group (*Antennaria, Gnaphalium,* and *Filago*), the Mugworts (*Artemisia*), Tansy (*Tanacetum*), Sea Cudweed (*Diotis*), and Bur-Marigold (*Bidens*). But the presence or absence of ray-flowers is not an important or even a constant character. For instance, some of the Senecios have a ray, others none. Of these, the rayed Common Ragweed (*S. Jacobæa*) and the rayless Groundsel (*S. vulgaris*) will stand for examples; yet the Ragweed often is devoid of a ray, especially on coast sand-hills, where the rayless form is often the prevailing one, and the Groundsel may often be found with ray-flowers well developed. The Common Bur-Marigold (*Bidens cernua*), normally rayless, sometimes produces a ring of yellow ray-florets, which makes of this somewhat dull flower a quite showy plant. Of stem forms, our *Corymbiferæ* offer no great variety, the stems being usually herbaceous, upright, and branched. The genera *Petasites* and *Tussilago* (Butter-bur and Colt's-foot), however, offer good examples of strong underground creeping stems. These are possessed of much vitality, which makes the Colt's-foot a very difficult weed to eradicate. Similarly, the Winter Heliotrope (*Petasites fragrans*), a plant introduced from Sicily for the sake of its fragrant flowers produced in mid-winter, which has now run all over the country. From its interlacing, far-creeping tangle of subterranean stems, a growth of kidney-shaped leaves is produced, so dense as to exterminate every native herb which it encounters. The Flea-bane (*Pulicaria dysenterica*) and Sneezewort (*Achillæa Ptarmica*) have likewise far-creeping underground stems. The leaves of the Daisy group offer much variety. Especially noticeable is the development of grey felt in those species whose habitat renders it necessary to avoid too great transpiration. The most remarkable example of this is the rare Sea Cudweed (*Diotis maritima*), a plant of dry gravel-beaches, the stems, leaves, and even involucres of which are clothed with dense white felt, giving the plant a most remarkable appearance. We may note the same development of felt in the Cudweeds, all plants of dry places. The Sea Wormwood has its home habitat in salt marshes, and consequently finds it necessary to economise water; it also has its fine-cut leaves and its stems and inflorescence uniformly covered with grey felt. The Golden Samphire (*Inula crithmoides*), which has its habitat on sea rocks, has developed exceedingly fleshy leaves, like many of the halophytes, or salt dwellers; like the Samphire, after which it is called, these juicy leaves are deliciously aromatic. It is perhaps among some of the larger members of the Daisy group that the composite inflorescence attains its greatest beauty and perfection. Examine such a flower-form as the Ox-eye Daisy. First we have the close-lapping scales of the involucre, securely enclosing the whole, and protecting it when in bud. Then the splendid ring of ray-flowers, whose object is to render the inflorescence more conspicuous. Thus we find these enormously-expanded corollas often assuming a tint other than that of the main mass of flowers—white, when the disk is yellow, as in the Ox-eye; in other species blue, or purple, or yellow, accompanying a yellow or greyish disk. These ray-florets have sacrificed their perfection as flowers for the purposes of advertisement, and are usually devoid of stamens, or sometimes devoid of both stamens and pistil. Finally we have the dense mass of disk-florets, all perfect, producing a quantity of minute fruits. As for the fruit of the *Corymbiferæ*, a large number rely on wind carriage, and the calyx-segments take the form of hairs, which grow into a more or less perfect parachute to aid in transporting the comparatively large fruit to pastures new. These parachute-fruits we know well in the Groundsel, Colt's-foot, Hemp, Agrimony, and Sea Aster. A large number of other genera, among them the Daisy, Ox-eye, Chamomile, Mugwort and Yarrow, are devoid of conspicuous fruit-appendages of this kind, and apparently secure by the swaying of their stems a seed-dispersal sufficient for their needs. The Bur-Marigold derives its name from the fact that its fruits are provided with spines (the altered calyx limb) armed with reflexed hooks; when ripe the fruits easily attach themselves to the coat of any passing animal, and secure wide dispersal thereby.

FIG. 2.—The Golden Samphire. (Half natural size.)

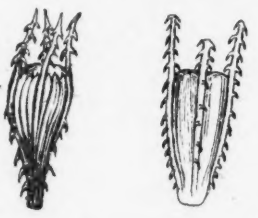

FIG. 3.—Fruits of Bur-Marigold. *a, Bidens cernua; b, B. tripartita.*

Turning now to the Thistle group or *Cynarocephaleæ*. Here we meet with perhaps the handsomest of our *Compositæ*—the Thistles, which must rank among the most beautiful of all the plant-forms which our country yields. Here, too, belong the Knapweeds (*Centaurea*), and the Burdocks (*Arctium*). In this section the flowers are all tubular, as in the disk of the *Corymbiferæ*. The flowers are also usually longer, producing a more oblong head, and the involucre-leaves (phyllaries) are more conspicuous in form and colour than in the Daisy group. The Thistles

themselves (*Carduus, Cnicus, Onopordon, Carlina*) are among the most perfect examples to be met with in our flora of defence against grazing animals. The beautifully-cut leaves are fringed with an array of spines of wonderful sharpness; the stems have often wings similarly armed; the leaves of the involucre end each in a spine likewise, sometimes of quite terrifying size, as in the Milk Thistle (*Silybum Marianum*). Were it not for this impenetrable armour the plants would early fall victims to herbivores, for the stems and leaves are juicy and sweet. The most perfectly protected of our native species is perhaps the little Carline Thistle; for the botanist who desires a

FIG. 4.—Carline Thistle (*Carlina vulgaris*). (Half natural size.)

specimen, the only method of securing one with an ungloved hand is to get down under the ring of basal leaves and grasp the strong tap-root. This species is also remarkable among British Thistles for the dry and woody nature of every part of the plant, which preserves its form unchanged if withered, so that one may even find in a sheltered spot a last year's and a this year's plant standing side by side, the former bleached and battered, but unchanged in form of leaf and flower.

Most of our Thistles are biennial herbs, forming in their first year a large rosette of spiny foliage, often of great regularity and beauty, and in their second year, shooting up, flowering, fruiting, and dying. A few species, however, notably the too common Field Thistle (*Cnicus arvensis*), have underground creeping stems. The stems of the Field Thistle plunge so deeply into the soil, grow so rapidly, and are so brittle and tenacious of life, that it is one of the most troublesome of all our weeds. The deeply lobed and spiny leaves of the Thistles are often coarsely hairy, but sometimes smooth and shining; in the Milk Thistle they are variegated by having the veins picked out in pure white. The leaves are often assisted in their function of assimilation by the leaf-like spiny wings which run down the stems, and protect them from injury. Almost all our Thistles furnish beautiful examples of parachute-fruits, each fruit being crowned with a spreading ring of delicate hairs, of which each one again bears a row of smaller hairs down each side. Suspended below this delicate framework the seeds are borne to long distances. Passing by the genera *Serratula* and *Saussurea*, each of which has but a single British representative, we come to the Knapweeds (*Centaurea*), which may chiefly claim attention here on account of the interesting variety which they offer in the form of the involucral leaves. Those of the Black Knapweed are familiar to every child whose luck it is to live in the country—curious little dark-brown objects, remarkably resembling certain small animal forms which even naturalists are generally glad to avoid. In other species they are yellow and chaffy. In *C. solstitialis*, St. Barnaby's Thistle, on the contrary, the phyllaries end in long slender spines, while in the Star-Thistle (*C. Calcitrapa*) the spines are much larger, stronger, and spreading, guarding the flower-heads like an array of bayonets. Another interesting point about the Knapweeds is that they show sometimes a differentiation in the structure and function of the flowers, as we have seen in the *Corymbiferæ*. This is best exemplified in the Blue-bottle (*C. Cyanus*), which brightens our corn-fields with stars of brilliant blue in autumn. The blue colour is derived entirely from the outer ring of flowers, which consist merely of brilliant corolla, the centre being occupied by numerous small close-set purple perfect flowers, which benefit by the visits of insects which the brilliance of the barren ray-flowers induces The Great Knapweed (*C. Scabiosa*) shows a corresponding division of labour. The Black Knapweed (*C. nigra*) has apparently not yet made up its mind whether to go in for a ray or not. Normally the flower-head consists of a solid disk of fertile flowers, but rayed forms are constantly to be met with.

Lastly we have the Dandelion group, or *Ligulifloræ*, represented by a dozen genera, most of which agree in having yellow heads of flowers closely resembling those of the Dandelion. The character of the group lies in these flower-heads, which are made up entirely of ligulate perfect flowers, in shape like the ray-flowers of the Daisy group. They are likewise distinguished by their milky, often acrid, juice. Only two of the British representatives of the group have flowers which are not yellow. These are the Chicory (*Cichorium Intybus*), whose large light blue flower-heads are such a delightful feature in sandy fields or on dry banks; and the Blue Sow-Thistle (*Mulgedium alpinum*), a handsome alpine plant, attaining a height of several feet, found on lofty mountains in a few localities in Scotland. One other not-yellow member of the *Ligulifloræ* finds a place in British Floras, though not a native, namely, the Salsify (*Tragopogon porrifolius*), which has naturalized itself in meadows in many places, being originally grown in gardens for the sake of its fleshy roots, which resemble Asparagus in flavour. This plant has heads of bright purple florets, which, like its near yellow-flowered relative,

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the Goat's-beard (*T. pratensis*), close at mid-day. The Goat's-beard being a common plant, this habit has been much commented on by the older writers, and has earned for it the name of "John-go-to-bed-at-noon." Some of the larger members of the Dandelion group vie with the Thistles in elegance of form. This is especially true of the Sow-Thistles; a well-grown specimen of *Sonchus asper*, with its stout hollow columnar stem, beautiful leaves cut and spiny, with spiny lobes clasping the stem in a curious spur-like fashion, and branching inflorescence, forms an object on which the eye of the plant-lover will rest with admiration and with pleasure.

The Hawkweeds (*Hieracium*) form a remarkable and bewildering group of allied forms, in regard to which, as in the *Rubi*, the term "species" is very difficult of application. Between one end of the series and the other —say between the single-headed alpine section and the tall much-branched *H. boreale* and its allies—a much wider gap exists than between the extreme ends of *Rubus fruticosus*, but nevertheless the gap is completely bridged over by intermediate forms, so that classification becomes nigh impossible. The Hawkweeds are mainly plants of mountain rocks; all are herbaceous perennials, with simple leaves and yellow flower-heads.

Our native *Compositæ* are, for so large a group of plants, singularly devoid of properties or uses. Most of them are harmless plants, and the stems or leaves of a good many have formerly been used as food, either boiled or as salads. A good many are of some use as tonics; a few are febrifuge, or vermifuge. The fleshy root-stocks of the Elecampane (*Inula Helenium*) are still sometimes candied; the Fleabane (*Pulicaria dysenterica*) was formerly, as its name implies, used in cases of dysentery. The Stinking Chamomile (*Anthemis Cotula*) is acrid, and its foliage will raise blisters on the skin; while the Strong-scented Lettuce (*Lactuca virosa*) has milky juice that is acrid and narcotic, and has been used as an opiate. The *Compositæ* can claim to supply, in Colt's-foot, Groundsel, and Thistle, some of the most persistent and troublesome weeds that occupy the attention of the British farmer or gardener. By far the most useful of the native species is the Dandelion (*Taraxacum officinale*), whose roots possess diuretic and tonic properties, and are still much in favour in pharmacy.

Conducted by M. I. CROSS.

POND-LIFE COLLECTING FOR THE MICROSCOPE.

By CHARLES F. ROUSSELET, F.R.M.S.

(*Continued from page* 141.)

THE group of attached forms of Pond-life comprise such Infusoria as *Carchesium*, *Epistylis*, *Zoothamnium*, *Stentor*, etc.; Rotifers such as *Melicerta*, *Stephanoceros*, *Floscules*, etc.; Hydra, all Polyzoa and Sponges. In searching for these forms, a quantity of pond weeds, or rootlets, are brought on shore with the cutting hook, and selecting some likely-looking, fairly clean branches, but not the newest growth, one twig after another is placed in the flat bottle in clean water, where it can be examined from both sides with great ease, both with the naked eye and the pocket lens. The tree-like Vorticella colonies: *Epistylis*, *Zoothamnium*, *Carchesium*, the trumpet-shaped *Stentors*, the Crown Rotifer *Stephanoceros*, the tubes of *Melicerta* and *Limnias*, the various Polyzoa, also Hydra and Sponges, and many others, can at once be seen when present, and in this way good branches can be selected and placed in a separate wide-mouthed collecting bottle containing clean pond water. A little experience will soon teach one which branches are likely to prove prolific. As a general rule one may say that old-looking, but still sound and green, branches will be the best. The water Milfoil (*Myriophyllum*) is one of the best of water plants to examine and collect, on account of the ease with which its leaves can subsequently be placed under the microscope. *Anacharis* is more troublesome, but it is occasionally found covered with Pond-life, and is an excellent weed for the aeration of aquaria.

The rootlets of reeds and of trees growing near the edge of the water should be examined for Sponges and Polyzoa, such as *Lophopus*, *Plumatella*, *Fredericella*, etc. In order to obtain some weeds growing near the middle of a pond or lake, a loaded three-pronged hook, attached to a line, may be used; this is swung round, and may be thrown to a distance of 20 to 25 yards, where it sinks, and the weeds that are caught by the hooks are dragged on shore.

By these various means a good collection of pond organisms can readily be made after a little practice. Though the spring and autumn are perhaps the best season for collecting, Pond-life is never absent, even in the winter under the ice.

Having thus filled some bottles with condensed water from various ponds, and placed some promising branches of water plants in another bottle filled with uncondensed and clean pond water, the bag is taken home. It is a great mistake, however, to overstock the bottles with weeds, as the plants in such crowded bottles may begin to decompose, killing most of the animals in a short time.

On reaching home, the first thing to do is to empty the collecting bottle into larger vessels or small aquaria in such a way that the captures may be more critically examined, isolated, and, if found desirable, placed under the microscope.

By far the best and most convenient way of doing this is to transfer the contents of each bottle into a small window aquarium, filling it up with tap water. The weeds and rootlets that have been brought home are put in another window aquarium in clean pond water.

These small window aquaria, with flat and parallel sides 6 to 8 inches long by 5 to 6 inches high and only 1¼ inches wide inside, are the best nurseries for the microscope. The difficulty of seeing and capturing small objects in a large or ordinary round aquarium is very great, and the use of the pocket lens almost hopeless, whilst in these flat and narrow aquaria no object is out of reach of the lens, and the whole contents can be looked over without difficulty and in a very short time.

By placing the tank on a what-not at a convenient height before a window, or before a lamp at night, most of the free-swimming Rotifers will collect against the glass nearest to the light, where they can be examined with the greatest ease and picked up with the pipette if desired. A disk of black cardboard placed some little distance behind, produces a very good dark ground, against which the smallest visible specks stand out well.

The condensed pond water is, of course, frequently so dirty with floating particles of *débris*, that it is at first hardly possible to see through it; but after standing half-an-hour it will be found that most non-living particles will have fallen to the bottom, and after several hours the water will be quite clear and every living creature will be readily seen.

During the summer months, when Daphnia and Cyclops are abundant, the net frequently collects these in such numbers that they become a nuisance. In order to separate them, when such is the case, I have adopted the plan of passing the water through a small sieve made of material with meshes sufficiently wide to allow the largest Rotifers and Infusoria to go through, whilst keeping back most of the Cyclops and Water-fleas; the latter are then transferred to a separate tank to be examined by themselves.

It is very desirable to examine the collected objects as soon as convenient, the same day if at all possible, and not later than the day after their capture, as many organisms soon die and disappear under the crowded and unnatural conditions in which they are kept in captivity. Rotifers can often, particularly in

cool and cold weather, be kept for a week or fortnight, and some species, such as *Melicerta*, occasionally for months if food-material in the shape of fresh pond-water can be provided. Failing pond-water, water from hay infusions, which mostly contains quantities of bacteria and minute Infusoria, may be added. The various species of Polyzoa and Sponges can also be kept alive a considerable time by feeding them in a similar way, but Hydras require a fare of Water-fleas if they are to thrive.

For keeping microscopic life I have found no difference between large and small aquaria, but the small tanks are the more manageable; the great thing to be attended to is the proper aeration with water plants, of which *Anacharis*, *Fontenalis*, and *Valisneria* are, perhaps, the best, and not to overstock the tank with either animal or vegetable life. The water need not be changed, but a little fresh pond water should be added from time to time. Larger animals, such as small fish, water-beetles and snails must be excluded altogether from small tanks, and Polyzoa and Sponges must be kept therein in very moderate quantity and small colonies only.

In order to ensure success it is essential to maintain a proper balance between the animal and vegetable life, and also to supply fresh food frequently, for microscopical animals no more than the larger beasts can live long without food. To some extent, no doubt, they feed on each other, but in a small aquarium their hunting ground is very limited and the game soon becomes scarce. *Asplanchna* can be seen under the microscope to feed on *Anuræa*, *Brachionus*, *Polyarthra*, *Triarthra*, and other Rotifers when it can catch them, and their shells and remains are frequently found in Asplanchna's stomach.

On the whole, the best plan is to go out and collect a fresh supply from time to time and as often as may be convenient. I may mention that at the middle of January, I had many thousands of Rotifers in a tank which I collected two days before in the Grand Junction Canal, near Westbourne Park Station. The Canal was covered with blocks of ice, and the time spent near the water did not exceed ten minutes, during which I filled a large bottle with water condensed by means of the ring net.

Everyone who has worked at Pond-life will have experienced how awkward it is to examine with a pocket lens and at the same time attempt to pick out a particular animal in order to place it under the microscope. In order to have both hands free for this operation, and to keep the lens fixed to a particular spot, I devised, some years ago, a small aquarium microscope* (Fig. 2), which is simply a flat metal arm, jointed in

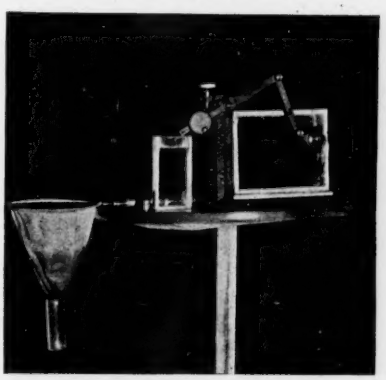

FIG. 2.—Mr. C. F. Rousselet's Tank Microscope and Window Aquarium, with the flat bottle and collecting net.

such a way that it allows the lens to be moved all over the surface, but in one plane only, parallel to the side of the window aquarium, whilst the lens is focussed by a small rack and pinion on the left. The whole apparatus is screwed on to a small wooden stand, on which the tank is placed. The lens used is Zeiss' aplanatic combination × 6 diameters, which has working distance enough to focus right through the tank, and sufficient amplification to enable one to recognise most Rotifers, Infusoria, etc., and anything uncommon or new can at once be detected and secured. Moving objects can readily be followed with the lens, and pond weeds can be searched for anything that may be growing on them, whilst the lens remains fixed in any position it may be placed. I have had this tank microscope in constant use for over twelve years, and can recommend it as thoroughly practical, efficient, and time-saving.

In a future paper I propose to describe those methods which long experience has proved to be the most practical in the examination of living objects under the microscope.

* Made by C. Baker, of High Holborn, and described in *Journal Quekett Micro. Club*, Vol. IV., 1890, pp. 53–54.

THE QUEKETT MICROSCOPICAL CLUB.—It may not be generally known that, in connection with this Club, excursions take place on Saturday afternoons during the summer season to hunting grounds that invariably yield rich spoil to the microscopist. Among the localities yet to be visited this season are Wallington, Totteridge, Chingford, and Hadley Wood. Those who may be interested in Pond-life and similar subjects would derive many advantages from becoming members of this Club, not the least of which is the opportunity of joining these excursions. Communications should be addressed to Mr. A. Earland, Reading Villa, Denmark Street, Watford.

ACCURATE WORKING.—The microscope never does its best except the user apply his best abilities to its manipulation. It is not to be expected that the worker who refers to his microscope as a matter of necessity or routine can give to every point the care that it deserves, and, indeed, properly requires, but it is not too much to expect that those who are engaged in original research, and those amateurs who have leisure and are provided with everything that is the most perfect of its kind, should employ it so as to secure the maximum effect. Those who have seen the wonderful manner in which a Test Diatom or a Rotifer will be displayed by one of our leading workers, will be disposed to credit the objectives used with the greater part of the effect, but it is almost invariably due to the exquisite care which has been bestowed on the arrangements in every small detail. So much of beauty and effect is lost through want of care or lack of appreciation of essentials, that it behoves those who use a microscope to devote to it all the practice and thought that will enable them to wrest from it the best it is capable of yielding. Enough has been written previously of the desirability of proportioning the aperture and power of the substage condenser to that of the objective, and of its use and adjustment, but it is scarcely recognised as it should be how much the critical sharpness and definition can be improved by the use of the mechanical draw-tube.

Neither the complete aperture of the objective nor its fullest correction for spherical aberration are utilised unless this important consideration is studied, and this means, further, that eyepieces of deep power cannot be so advantageously used if it is neglected. Some workers are not possessed of a really keen critical eye, and are not readily able to decide whether an objective works at its best within a variation of tube length of three inches or more, but it is possible to so cultivate this quality as to be sensible of a lessening of effect if the tube length be varied so small an amount as one millimétre, that is, assuming that every other detail has received equal attention. It would be a good manipulative exercise for those who are really interested in seeing all the microscope is capable of revealing, to give careful attention to the minuter details, and especially to the adjustment by tube length.

MOUNTING NOTES.—*Mosses and Liverworts.*—A correspondent has sent some interesting suggestions arising out of the article by Mr. Russell on this subject.

He remarks that "Good glycerine-jelly will not deliquesce in ordinary temperatures; but, like all gelatinous substances, is extremely sensitive to changes of temperature, more especially when accompanied by moisture, expanding and contracting freely. The cement placed round the cover-glass is necessarily rigid, and the cover-glass being usually finally cleaned while held between the thumb and finger, a little grease probably adheres to an occasional edge. Presuming this to be so, when expansion takes place tiny apertures permit the jelly to escape; in fact, when the cement extends some distance over the cover-glass capillarity actually invites such escape."

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He therefore uses no cements, but after allowing a fortnight for drying, he covers the remainder of the slip with paper, being careful to avoid any pressure when applying it. By this means he has been able to secure mounts which have every promise of permanence, and much trouble in the preparation is obviated.

NOTES AND QUERIES.

W. H. Young.—Mr. J. T. Neeve suggests that you soak the Algæ in methylated spirit for some little time to make them transparent, and, in order that you may experiment, I have sent you some fronds that I have received from him, but is it really necessary for such delicate specimens as *Delisseria* to be treated in this way at all? Are they not sufficiently transparent for lantern projection without this?

E. W. Napper.—The following is the formula for Deane's medium :—

Gelatine	...	...	...	1 oz.
Honey	...	...	...	5 ozs.
Water	...	...	...	5 ozs.
Rectified spirit		...	...	½ oz.
Creosote	...	...	...	6 drops.

Soak the gelatine in the water until soft, add the honey, then boil the mixture. When it has cooled somewhat, the creosote mixed with the spirit is added. Lastly, filter through fine flannel. The medium is used warm.

A. H. Brett.—The specimen you send is an egg cluster of whelk.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn*, *W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

FAYE'S COMET.—This interesting periodical comet has probably returned to perihelion this year after a much shorter interval than usual, having experienced considerable perturbation from Jupiter. No information of its recent redetection has, however, come to hand, and the probabilities are that it will escape notice owing to its unfavourable position. This comet has been observed during each of the seven returns which it has made since 1843, and its average period has been 2735 days or 7·488 years. The following is a list of the dates of its perihelia and of its periods of revolution :—

Perihelion Passage.	Period of Revolution. Days.	Date of Discovery.	Discoverer.
1843 October 17	.....	1843 Nov. 22	Faye
1851 April 3	2725	1850 Nov. 28	Challis
1858 September 12	2719	1858 Sep. 8	Bruhns
1866 February 13	2711	1865 Aug. 22	Thiele
1873 July 18	2712	1873 Sep. 3	Stephan
1881 January 22	2745	1880 Aug. 25	Tempel
1888 August 9	2756	1880 Aug. 19	Perrotin
1896 March 19	2779	1895 Sep. 26	Javelle
1903 June 3	2631 (Predicted)		

Dr. Elis Strömgren, of Kiel, gives the following ephemeris in *Ast. Nach.*, 3858 :—

Date 1903.	R.A. H. M.	Dec. °	Brightness.
June 26·5	4 42	+ 18·6	0·055
July 18·5	5 46	+ 18·4	0·053
Aug. 9·5	6 45	+ 16·8	0·051
,, 31·5	7 39	+ 14·1	0·049

When last seen on 1896, January 15, the light of the comet was = 0·061, so it should be rather fainter than that during the present summer, when it will be not far west of the sun and moving from the head of Taurus, through Gemini, into Cancer.

NEW COMET.—On April 17, Mr. J. Grigg, of Thames, New Zealand, discovered a small comet in the S.E. region of Cetus. It was soon found that the object had passed its perihelion on March 25 and was receding both from the sun and earth. It was observed by Mr. John Tebbutt at Windsor, N.S.W., on April 26, but its position since its discovery has been too far south for English observers to obtain a view of it.

APRIL METEORS.—Prof. A. S. Herschel, at Slough, secured a valuable series of observations between April 16 and 23, watching for 21 hrs. 20 mins., in the aggregate, and recording 85 meteors, of which 23 were Lyrids. Meteors were generally very scarce. 8 Lyrids were seen in 2¾ hrs. on April 21, and 11 in 5 hrs. on April 22. The radiant was at 269° + 34°, and about 4 degrees in diameter.

Mr. A. King, of Leicester, watched for meteors on nine nights, from April 15 to 24, the weather being extremely favourable. In 19½ hrs. observation he registered 80 meteors, including 25 Lyrids. The latter were nearly all seen on April 21 and 22, and the maximum occurred on the 21st, but it was rather a feeble display.

Several bright meteors were also seen from a radiant at about 216° − 26°, which represents a return of a well-defined shower observed by Prof. Herschel and others, from the point 218° − 31°, during the April epoch of 1900.

MAY AQUARIDS.—A rich display of these meteors was observed by Mr. G. M. Knight, of London, W.C., on the first four mornings of May last. 25 Aquarids were recorded, of which 18 were equal to or exceeded stars of the 1st mag. in brilliancy. They had long flights, slow motions, were generally of an orange colour, and left fine trails. The mean place of the radiant was at 330° ± 0°, but Mr. Knight thought that the point exhibited a decided N.E. movement during the four nights of observation, the centre, before sunrise on May 1, being at 327° − 3°, while on May 4 it appeared to be at 332° + 3°.

MAY METEORS.—A period of very clear summer-like weather occurred between May 18 and 31, and observations were obtained by the writer, at Bristol, on 11 nights. Meteors were, however, visible in scanty numbers, only 75 being noted in 18½ hours of watching. There were feeble radiants at 194° + 58°, 248° + 27°, 263° + 37°, 273° + 22°, 278° + 31°, 311° + 80°, 330° + 58°, and 331° + 72°. Perhaps the most interesting object recorded was a small fireball, which appeared on May 26, 13h. 48m., falling very slowly in 4 seconds, from 143° + 71° to 98° + 66½°. A stream of yellow sparks followed in the immediate wake of the nucleus as it sailed leisurely down the northern sky.

DOUBLY-OBSERVED METEOR.—Prof. Herschel, of Slough, recorded a meteor, equal in brightness to Vega, on May 26, 11h. 47m. It traversed a path from 225° + 73½° to 172° + 56° in 1·2 seconds, and left a rather bright, white streak. The same object was observed by the writer at Bristol, moving rather slowly from 315° + 37° to 309° + 61° in 2 seconds, and leaving a bright streak along three-fourths of its track. The meteor was evidently an early Pegasid directed from 321° + 11°. Its luminous flight began at a height of 64 miles over Dunstable, and ended near Burford, Gloucestershire, extending over 51 miles at a velocity of 31 miles per second.

LARGE METEORS.—On May 8th, 5h. 30m p.m., Miss Westmacott, at Haslemere, Surrey, observed what appeared like a silver meteor travelling with great speed from E. to W., at an angle of about 35 degrees. On Sunday, May 24th, two bright meteors were noticed by the Rev. W. F. A. Ellison, of Enniscorthy. The first appeared at 10h. 20m G.M.T., and was about equal to Venus. It passed slowly from 180° − 8° to 133° + 12¼° in 6 seconds. Colour white or yellowish. It left a long faint train. The second meteor appeared at 10h. 59m. G.M.T., and was of the brightness of Mars. It travelled from 172° + 51° to 267° + 73° in 3 seconds, and left a broad and strong nebulous train. The radiants of these meteors were probably at 252° − 24° and 147° − 12°, but no other observations have come to hand.

THE FACE OF THE SKY FOR JULY.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 3.48 and sets at 8.18; on the 31st he rises at 4.22 and sets at 7.50.

The earth is at its greatest distance from the sun on the 3rd, when the sun is in apogee, and then has its least apparent diameter of 31′ 30″·6.

Small groups of sunspots have been frequent of late.

THE MOON :—

	Phases.	H. M.
July 1	☽ First Quarter	9 2 P.M.
,, 9	○ Full Moon	5 43 P.M.
,, 17	☾ Last Quarter	7 24 P.M.
,, 24	● New Moon	12 46 P.M.
,, 31	☽ First Quarter	7 15 A.M.

The moon is in apogee on the 10th, and in perigee on the 24th.

There are two occultations of comparatively bright stars during the month. The particulars are as follow:—

Date.	Star Name.	Magnitude.	Disappearance.			Reappearance.			Moon's Age.
			Mean Time.	Angle from N. Point.	Angle from Vertex.	Mean Time.	Angle from N. Point.	Angle from Vertex.	
			h. m.	°	°	h. m.	°	°	d. h.
July 9	ρ^1 Sagittarii	3·9	8 4 P.M.	63	97	9 11 P.M.	291	317	14 14
„ 19	38 Arietis	5·2	1 50 A.M.	52	92	2 47 A.M.	272	310	23 20

THE PLANETS.—Mercury is a morning star in Gemini, rising about an hour before the sun at the beginning of the month; this interval, however, rapidly diminishes and the planet is in superior conjunction with the sun on the 26th.

Venus is an evening star, and increasing in brilliancy in consequence of her diminishing distance from the earth. She attains her greatest easterly elongation of 45° 30′ on the 10th, when she exhibits the phase of the half moon and has a diameter of 25″. The diameter of the planet rapidly increases from 22″ at the beginning of the month to 32″ at the end, whilst the phase changes to crescent at a correspondingly rapid rate. The period of "greatest brilliancy" does not take place until about one month after greatest elongation. At the middle of the month the planet is on the meridian at 3.7 P.M., having an altitude of 47½°; a little searching with a pair of field-glasses should enable the planet to be found readily. On the 1st of the month Venus sets at 10.30 P.M., and on the 31st at 9 P.M.

Mars is getting more to the west, and also is decreasing in brightness. During the month the diameter decreases from 8″·4 to 7″·2. On the 1st he sets at 11.45 P.M., and on the 31st at 10.10 P.M. The planet is describing a direct or easterly path in Virgo, and on the 22nd passes about 1½° north of Spica. Mars is in quadrature with the sun on the 6th, when he presents the maximum gibbosity, 0·87 of the disc being illuminated. The planet is near the moon on the 1st, and after he has set to the British Isles he approaches at 2 A.M. on the morning of the 2nd within 9′ of the southern limb of the moon.

Jupiter rises on the 1st about 11.20 P.M., and on the 31st at 9.20 P.M., therefore as Venus is setting Jupiter is rising. The planet is describing a direct path in Aquarius up to the 14th, when he is stationary, after which date his motion is retrograde. About the middle of the month the polar diameter of the planet is 41″·4. This year the planet will be a little better placed than last, since he is gradually moving to a higher declination.

Saturn is in opposition on the 30th; he is situated in Capricornus, and rises on the 1st about 9.45 P.M., and on the 31st about 7.45 P.M. The planet, however, is not very favourably situated on account of his south declination of 19°. The polar diameter of the ball is 17″·2, and the outer diameters of major and minor axes of the ring are 42″·9 and 13″·7 respectively. The northern surface of the ring is visible.

Uranus rises about 7 P.M. on the 1st, and about 5 P.M. on the 31st; near the middle of the month he is on the meridian at 10 P.M. As shown by the chart in last month's number, his path lies near 51 Ophiuchi.

Neptune is out of range, being in conjunction with the sun towards the end of last month.

THE STARS.—About 9 P.M. near middle of the month:—

ZENITH	Draco, Hercules, Lyra.
SOUTH	Corona, Serpens, Ophiuchus, Libra, Scorpio.
EAST	Delphinus, Aquila, Capricornus; Sagittarius to the S.E.; Pegasus and Cygnus to the N.E.
WEST	Bootes, Great Bear, Cor Caroli, Leo, Virgo.
NORTH	Ursa Minor, Cassiopeia; Capella on horizon.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of June Problems (J. C. Candy).

No. 1.

1. R to Bsq, and mates next move.

No. 2.

Key-move—1. R to Kt2.

If 1. . . . P to R3, 2. R to R2.
1. . . . K to K5, 2. R to B2.

SOLUTIONS received from "Alpha," 2, 4; W. Nash, 2, 4; G. A. Forde (Major), 0, 0; "Looker-on," 2, 4; W. H. S. M., 2, 4; G. W. Middleton, 2, 4; "Quidam," 2, 4; J. W. Dixon, 2, 4; C. Johnston, 2, 4; H. F. Culmer, 2, 4; T. Dale, 2, 4; E. A. Servante, 2, 4; A. H. H. (Croydon), 2, 0; W. J. Lawson, 0, 0.

Solution of Conditional Problem (Mrs. Baird).

White's last move was P (Q5) × Kt at K6. He retracts this and plays instead B to Ktsq. Black then plays Kt to QB4, allowing B × B mate.

Correctly solved by J. W. Dixon, C Johnston, G. A. Forde (Major), W. H S. M., H. F. Culmer, W. Nash, T. Dale.

G. A. Forde (Major).—Probably I need not point out where you have gone astray. I suspect that your 1. RQB5 was a clerical error.

W. Nash.—15. P to Kt3 was an unfortunate misprint for B to Kt3. So also 18. R to Q2 for B to Q2, as you correctly guess.

P. H. Williams.—Many thanks. They shall appear before the year is out.

Hamilton White.—I must explain that a "cook," in chess parlance, signifies a second solution. To "suspect a cook" means therefore to suspect the possibility of a second solution; not, as you appear to take it, to suspect the *bona fides* of a correspondent.

E. A. Servante.—I expect that your problems will be found up to the standard.

SOLUTION TOURNEY.

The following are the principal scores up to the end of June:—

W. Nash	38
Looker-on	38
J. W. Dixon	38
C. Johnston	38
W. H. S. M.	34
G. W. Middleton	34
Alpha	30
A. H. H. (Croydon)	30
Quidam	29

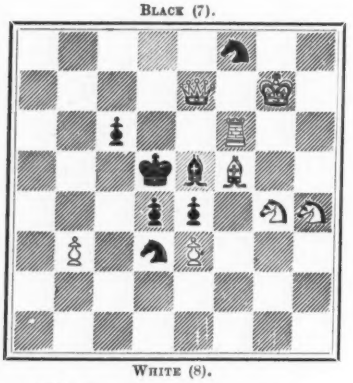
XUM

PROBLEMS.

By P. G. L. F.

No. 1.

BLACK (7).

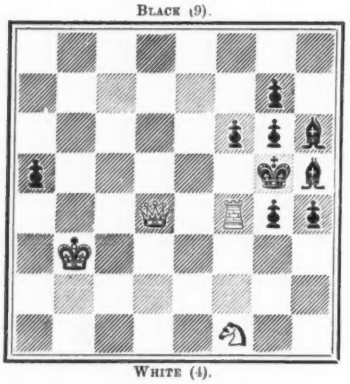


WHITE (8).

White mates in two moves.

No. 2.

BLACK (9).



WHITE (4).

White mates in three moves.

The very lively game below was played in the Monte Carlo Tourney.

"Centre Counter Gambit."

WHITE. Dr. Tarrasch.	BLACK. J. Mieses.
1. P to K4	1. P to Q4
2. P × P	2. Q × P
3. Kt to QB3	3. Q to QR4
4. P to Q4	4. Kt to KB3
5. B to Q3	5. B to Kt5
6. KKt to K2	6. P to K3
7. B to KB4 (*a*)	7. Kt to Q4
8. B to Q2	8. Kt × Kt
9. P × Kt	9. Kt to Q2
10. Castles	10. P to QB3
11. Q to Ktsq (*b*)	11. B × Kt
12. B × B	12. Q to B2
13. P to KB4	13. B to Q3
14. B to Q3	14. P to KKt4
15. Q to Bsq	15. Kt to B3
16. P to B4	16. Kt to R4
17. P to Kt3	17. P × P
18. Q to Qsq (*c*)	18. Kt to Kt2
19. P to B5	19. B to K2
20. B × P	20. Q to Q2
21. P to B3	21. P to KR4
22. B to K5	22. K to Bsq
23. B to Kt6	23. P to B4
24. B × RP	24. B to Kt4
25. B to B3	25. R to R3
26. K to Kt2	26. K to B2
27. P to KR4	27. B to K6 (*d*)
28. Q to K2	28. P to B5
29. Q × B (!)	29. Kt to B4
30. Q × P	30. R to KKtsq
31. Q × R (!)	Resigns.

NOTES.

(*a*) Apparently wasted time, but the same would apply to Black's reply.

(*b*) To unpin the Knight. By its capture Black gives his opponent the advantage of two Bishops in an open position.

(*c*) Black is now caught in a trap of his own setting. His last five moves have simply been waste of time, and he now loses the Pawn gained, and obtains besides a practically losing position.

(*d*) Apparently overlooking the uselessness of his next move; but in any case the position is quite hopeless. The White Queen does some surprising execution at the end.

CHESS INTELLIGENCE.

The following was the final result of the "King's Gambit" Tourney at Vienna:—M. Tchigorin, 13; F. J. Marshall, 11½; G. Marco, 11; H. N. Pillsbury, 10 G. Maroczy, J. Mieses and R. Teichmann, 9; Sviderski, 8½; C. Schlechter, 7; I. Gunsberg, 2. Mr. Teichmann would have been higher but for ill-health, but Mr. Gunsberg made a very disappointing reappearance.

The Championship of the Southern Counties' Chess Union has been won for the seventh time by Surrey, for whom Mr. G. E. Wainwright has played at the top board. Worcestershire, led by Mr. Bellingham, have come out at the head of the Midland Counties' Union for the third year in succession.

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